INVESTIGATION OF VELOCITY FIELD ABOUT A TWO DIMENSIONAL PLEXIGLASS OGIVAL FOIL USING THE LASER DOPLER ANEMOMETER

Gary J. Tettelbach

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by

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B.S.(NA) U.S. Naval Academy
(1970)

Submitted in partial fulfillment
of the requirements for the degree of

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and for the degree of

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June, 1978

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Accepted by________________________________
Chairman, Department Committee
on Graduate Students

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GARY J. TETTELBACH

Submitted to the Department of Ocean Engineering on May 12, 1978, in partial fulfillment of the requirements for the degrees of Ocean Engineer and Master of Science in Naval Architecture and Marine Engineering.

ABSTRACT

Until recently measuring the velocity of a fluid required the insertion of some instrument into the flow which would disturb the flow. The development of the laser dopler anemometer has created a means of measuring flow velocity using two intersecting monochromatic light beams, one of which has been shifted in frequency a prescribed amount. In order to use the type of laser dopler anemometer owned by M.I.T. the light beams must be able to traverse the test section and the scattered light be collected by the receiving optics. This requires a transparent model in order to measure the flow around the entire model. This thesis demonstrates the feasibility of such a method and is an account of the special techniques used to obtain the data.

Thesis Supervisor: Professor Justin E. Kerwin
Title: Professor of Naval Architecture

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To John Hammond and Bill Shepherd the author also owes the many hours of work they saved him by letting him use their computer program and plexiglass foil respectively.

Finally the author wishes to thank Fred Haberlandt, Mark Lipsey and Pat Weiland for their help in reaching the point where he could do this thesis and then finish it.

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I. INTRODUCTION

A variable speed water tunnel in a common laboratory for conducting hydrodynamic experiments involving Reynolds Number scaling. Until recently, however, there has been no reliable method in water tunnels of measuring either point velocities or pressures in a flow without disturbing the flow. Hot wire anemometers or pitot tubes require the insertion of an instrument into the flow and can cause a disturbance of the flow. The recent development of the laser dopler anemometer, LDA, has led to a method of obtaining point velocities without the insertion of any instrument into the flow which could alter the characteristics of the flow. The detailed operation and theory of the LDA will be covered in another section so let it suffice to say now that by having two monochromatic light beams, one of which has been shifted in frequency, intersect the velocity of the water at the point of intersection can be measured by collecting the scattered light.

The LDA at MIT is only capable of collecting the light scattered in the direction in which the beams are aimed. This means that the light must be able to pass completely through the water tunnel when attempting measurements. There is no problem with this if the only measurements needed are upstream or downstream of the model in the tunnel because the viewing ports or windows are transparent plexiglass. Measurements cannot be taken around a model which is opaque, however.

The purpose of this thesis is to demonstrate that by using a transparent model; in this case a two dimensional, plexiglass, ogival section foil; the entire velocity field around the model can be obtained. The problems associated with this involve both the optical characteristics of the model and the intensity of the scattered light when it has passed through the model. The positioning of the instrumentation that receives the scattered light is critical and resolution of the optical effect of the model on the scattered light becomes difficult. Any imperfections in the model also tend to diminish the intensity of light which eventually reaches the receiving optics. The results contained within this thesis are not necessarily intended to be extraordinarily revealing in hydrodynamic significance but rather are intended to describe and verify a new technique in collecting detailed accurate velocity data around a transparent model in the variable speed water tunnel using a laser dopler anemometer.

II. EXPERIMENTAL SET UP

This experiment was conducted in the variable speed water tunnel at MIT. The tunnel is a recirculating type tunnel with a test section which is basically a rectangle twenty inches high, twenty inches wide and with a region of undistrubed parallel flow approximately four feet in length. The model was held in place using the rudder and keel dynamometer on the top and just a sealed shaft through the bottom window. This is the normal method for testing two dimensional foils at the MIT facility. No splitter plate was used in order to allow maximum span of the foil which would reduce any end or wall effects. The foil was aligned in the tunnel to zero angle of attack by measuring the distance from the wall. The telescope atop the dynamometer was then zeroed and used to adjust the angle of attack thereafter.

Because of the lens effect of the foil, velocity measurements were only taken on the transmitter side of the foil. The lens effect changed the crossing angle of the beams which made the calibration of volts to feet per second and the position of the measuring volume unknown. To obtain measurements on both sides of the foil, the foil was flipped end for end.

The actual construction of the foil was done by Bill Shepherd for a 13.04 project and donated to the author. The method of construction was to take a rectangular piece of plexiglass and first use a milling machine and large rotating

table bed to get a circular arc. The second step was to polish the foil until transparent with progressively finer sandpaper and polishing compound. The difficult areas were the leading and trailing edges because of their fineness. Keeping the circular arc and yet getting rid of all defects and scratches requires more sophisticated equipment than was available. However, the foil is a masterpiece of hand craftsmanship and far better than the author could have done personally. The final foil dimensions are shown in figure 1.

The laser itself was resting on a base capable of movement in two degrees of freedom. The one degree of freedom in which the laser could not move was a chordwise movement. This was a very time consuming restriction because to move from station to station along the chord both the transmitting and receiving optics had to be manually picked up, moved, and realigned again. The base on which the laser rested never had to be moved because large enough plywood platforms were installed to allow enough laser movement to position the laser at all stations on the chord. Figure 2 shows the receiving optics, test section and dynomometer with telescope. Testimony to the quality of the foil is that it was in the test section when the picture was taken. Figure 3 shows the transmitting optics, vertical adjustment wheel and the station marking taped on the outside of the test section window.

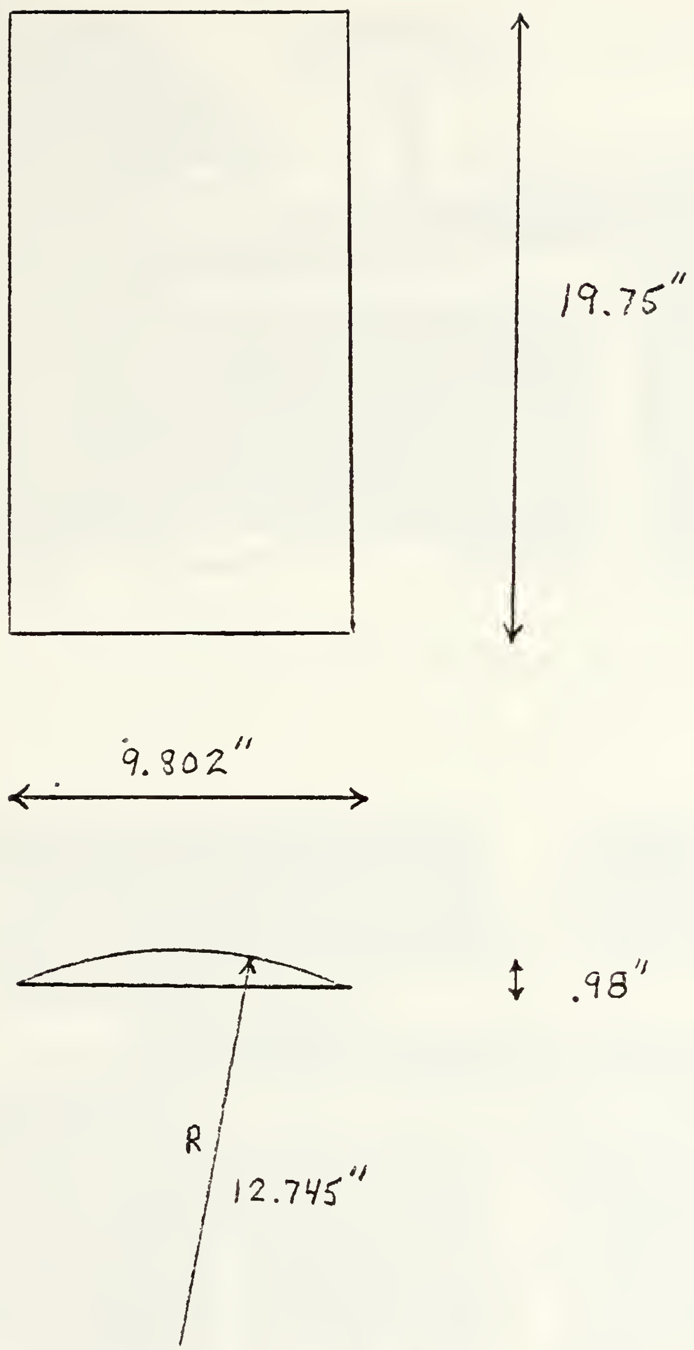

FIGURE 1 - Foil Dimensions

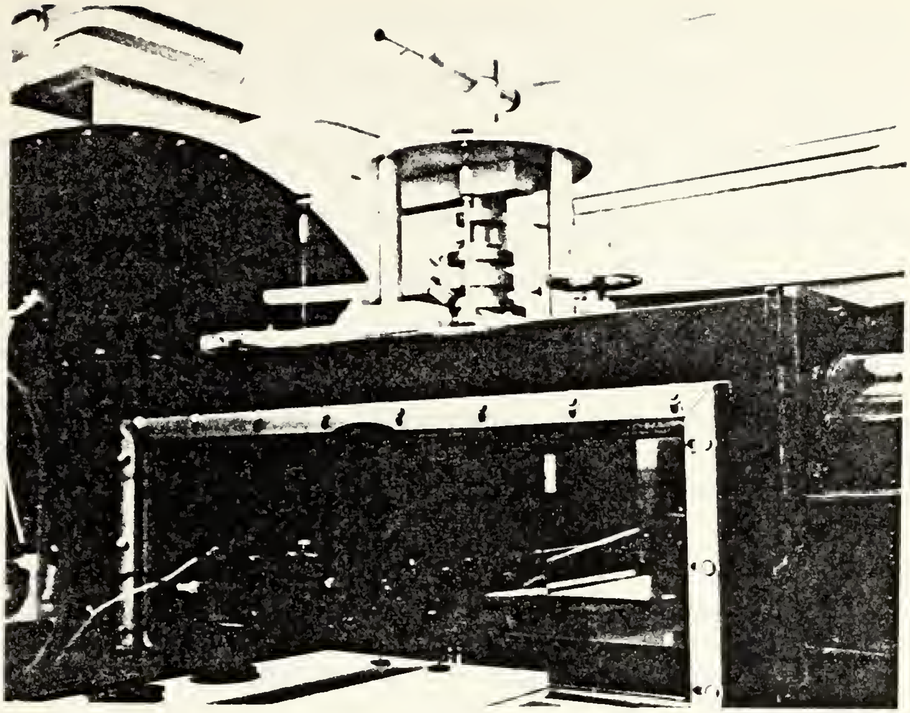

FIGURE 2 - Receiving Optics, Test Section, Dynomometer

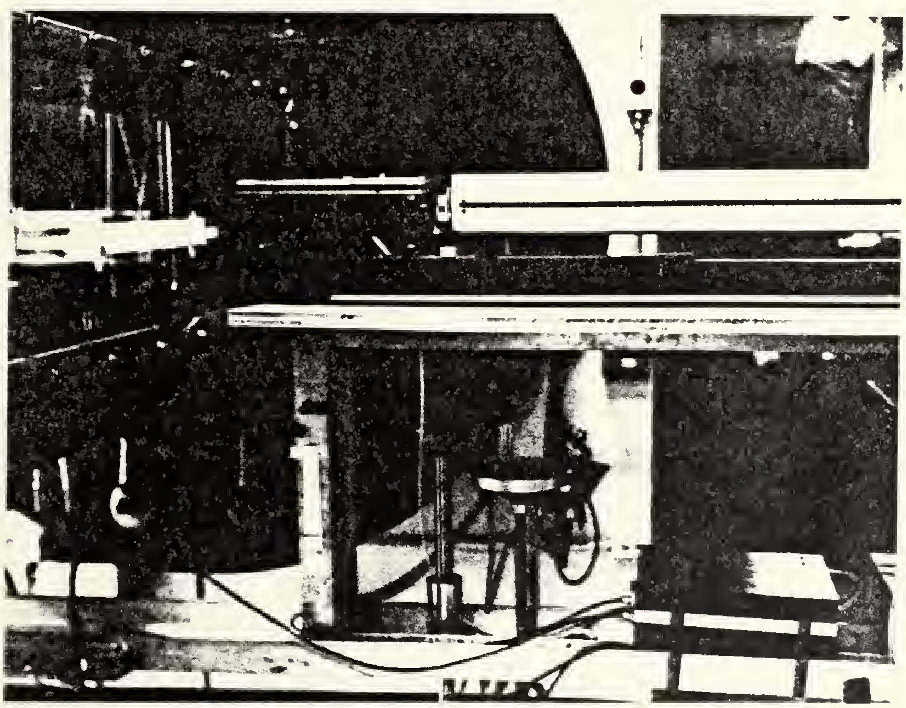

FIGURE 3 - Transmitting Optics, Vertical Adjustment, Station Spacing

To determine the precise position of the measuring volume, the chordwise position of the stations had to be determined. This was done by using the laser to mark on a tape placed on the outside window of the test section the exact position of the leading and trailing edges. This tape was then marked off in cosine spacing and left taped to the window for the duration of that test. The chordwise positioning of the laser was the least precise measurement of the experiment.

The rest of the electronics including the signal processor and tracker for the laser, the voltage to frequency converter, the time averagers for the impeller RPM and converter, and the oscilloscope were all mounted on a table or moveable stand. These locations are strictly a matter of personal preference and of no relevance to the experiment.

III.1 LASER THEORY

The author had difficulty when beginning his research finding a reference which was either complete, concise, or clear on the actual theory of laser dopler anemometer operation. In the following section is a brief overview of laser theory, but for anyone interested in specifics Peter Min's doctoral thesis, "Numerical and Experimental Methods for the Prediction of Field Point Velocities Around Propellor Blades" is to be completed in May 1978 and contains the best reference the author has been able to find.

The laser dopler anemometer is comprised of three major groups, the transmitting optics, the receiving optics, and the signal processing electronics. The transmitting optics produces a single monochromatic beam which is then split by a prism into two beams. One of these beams then passes through the Bragg cell which shifts the frequency of the light by a piezeo-electric process. This shift can be varied from .01 to 20 megahertz depending on the expected water velocity fluctuations, and allows the electronics to recognize negative velocities. The two beams are then focused by a lens of known focal length. In this experiment the focal length was 309 mm. A longer focal length is necessary if data is to be taken the complete width of the tunnel but this lens was adequate because data was only taken on one-half of the tunnel. The point of intersection of the beams is the measuring volume,

which is approximately .227 mm in diameter. In the measuring volume the intersection of the light beams sets up a series of frequency fringes. As a particle in the water passes through these fringes light is scattered at a frequency proportional to the speed of the particle. The light is scattered in all directions but the maximum intensity is in the direction of the laser beams and equidistant from each beam. The velocity measured is the velocity in the plane of the two beams and perpendicular to the line that bisects the two beams.

The receiving optics is placed on the same structure as the transmitting optics on the opposite side of the tunnel and aligned with it so as to collect the maximum intensity of scattered light. There is a lens which focuses the light on a photo-dectector. This photo-dectector produces a voltage proportional to the frequency of the scattered light.

The electronics takes the signal from the photo-dectector processes it through a series of filters, and tracks it. The tracker produces a visual display of the voltage over each second. With the electronics the number of particles counted per second and the filtering can all be adjusted to the conditions present. To average the voltage over ten seconds the voltage was converted to frequency and averaged over ten seconds.

III.2 LASER DOPLER ANEMOMETER TECHNIQUES

This section is intended to be a documentary on the author's learning process while conducting this experiment. Hopefully, by reading this anyone who attempts a similar experiment can avoid many frustrations and pitfalls.

To operate a laser dopler anemometer takes patience and experience. There is an art involved and practice is the best way to acquire expertise. Probably the most intelligent move the author made in the collection of data was to start testing in the first week of November of 1977. This one week was not very productive in the way of data taking but extremely important in learning how to operate the laser. Between this week and the next opportunity the author had to test in the water tunnel there was time to evaluate methods and procedures and study more on the aspects of operation that needed improvement. The data collected in February of 1978 not only has a higher confidence level it also was taken much faster and more easily.

The first step in the learning process was in determining the position of the measuring volume. The method of determining chordwise position was improved by two simple procedures. First, the author learned that by unscrewing two screws the laser beams could be aligned vertically. This greatly aided in determining the exact position of the leading and trailing edges. Secondly, there is a smoked glass filter

which decreases the intensity of the laser beams. By decreasing their intensity aligning was easier and the positioning at each station more accurate because the light could be made to a much finer dot on the marking tape.

An order of magnitude improvement in accuracy was made in determining the distance of the measuring volume from the foil surface between November and February. For the initial tests the distance of the laser lens from the tunnel window was measured and measuring volume position was in terms of a distance from the tunnel wall. The problem was determining the exact position of the foil in terms of distance from the wall. The solution was to place the measuring volume just on the edge of the foil visually and then record the laser position by reading the pointer on the movable base of the laser. The other data points were determined by a simple linear relationship of laser movement to measuring volume movement. The only problem with this method was at stations one and nine. There the foil was so thin it became difficult to determine on which side of the foil the measuring volume was.

The determination of free stream velocity was also improved between test periods. The procedure of reading the manometer for each data point was not only tedious to record but tedious to convert to speed later. By taking and averaging the impeller RPM over ten seconds and taking a manometer reading over that same ten seconds a linear relationship

between RPM and free stream velocity was developed. By averaging twenty-five of these readings a coefficient in terms of velocity per RPM was developed. A new coefficient had to be determined for each angle of attack, however, because the blockage of the model changed for each case. Another convenience of this was that the output of the laser tracker was averaged over the same ten second period.

To overcome the problem of the optical effect of foil acting like a lens was of great concern at first but really turned out to be a minor problem. After a brief study of optics, the author decided calculating the position of the receiving optics would be futile at best. The best method turned out to be visual adjustment. First two pieces of tape were placed on the window on the receiving optics side to block the two laser beams from exiting the tunnel test section. This was important for safety to prevent any eye damage while visually focusing. The receiving optics was then manually moved on the plywood base until the focusing pattern was symetrical and at maximum brightness. As a result of the focusing effect of the foil the receiving optics were only perpendicular to the window at zero degrees angle of attack and at station five. Maneuvering the receiving optics while looking through the eyepiece was awkward and certainly not precise but it was effective. At the stations near the leading and trailing edges re-focusing was required about every other data point and this

was tedious, but there was no better alternative. To align the receiving optics exactly so as not to require such frequent refocusing would have taken exorbitant amounts of time if possible at all.

In November it was obvious that there were defects in the foil, particularly near the leading and trailing edge. By moving just fractions of an inch spanwise, reception of the signal improved greatly because the light was not being dispersed by a nick or imperfection in milling. This vertical movement was also used to avoid window scratches. Another method of improving reception, dealing with the model and windows was to ensure they were clean. Wiping them both with soft tissues and alcohol has a much more dramatic effect than it would appear.

Of the three areas of adjustment; the foil, the water, and the laser; the water could be least affected or adjusted. If the water is very cold, below sixty degrees fahrenheit, readings are very difficult to obtain. The number and type of particles also is important. There are several types of additives on the market today which can be added to improve water characteristics but they are costly and do not stay in the system. Ordinarily there were enough particles in the water for adequate laser operation, but if more particles were needed the addition of four teaspoonsfull of "Coffeemate" was helpful. These particles dispersed evenly in the tunnel

and appeared to be the correct size to improve operation. The question of when should particles be added is best answered by experience. If all else seems to be functioning properly but the signal will not track the addition of particles can't hurt.

Most of what appears to be "tricks of the trade" in obtaining meaningful data are involved with adjustment of the laser itself. The references mentioned in section 3.1 are very helpful in understanding how the laser operates and how to obtain a signal when conditions are ideal. In the case of this experiment, however, conditions were seldom even close to ideal. Therefore, several ways to improve the signal characteristics or detect weak signals were devised. The first step was to do the easiest station, station five, first to ascertain that all of the equipment did indeed operate and the laser was aligned. Once the laser beams were aligned they did not abruptly go out of alignment. The deterioration was gradual and if suddenly one data point would not track the chances were very slim that it was due to misalignment of the laser if the previous data point had a good signal. The quality of the signal oftentimes could be improved by blocking out unwanted beams. The beam that was shifted in frequency in the Bragg cell came out of the transmitting optics surrounded by three extraneous beams of weaker intensity. These beams often

would scatter light when they impinged on the foil and increase the noise in the received signal enough to make the signal indecipherable. By taking a small piece of black tape and carefully placing it on the tunnel window these beams could be removed. To insure the correct beam was still entering the water the Bragg cell was turned off. This eliminated the frequency shift and left only one beam, the correct one. Once it was determined the correct beam was not blocked the Bragg cell was turned on again.

The laser dopler anemometer will always produce a reading of some kind. To master the LDA is to know when that reading is the correct reading for the water velocity in the measuring volume. The most helpful instrument in doing this was the oscilloscope. Unfortunately, the author did not use the scope until test forty-four out of sixty-nine tests. But in terms of accuracy of data this was a major breakthrough. What the oscilloscope did was visually display the signal coming from the photomultiplier and allowed confirmation that it was indeed the true signal. It could, of course, display more but the key to determining good data from eroneous noise was looking at the raw signal before it entered the signal processer. Sometimes this was more difficult than others. If the signal was very weak and there was very little noise, a magnificent looking signal showed on the scope. This was the frequency shifter dominating the

signal. Whatever megahertz shift was set on the frequency shifter showed up on the oscilloscope looking very much like the true signal. An easy way to discern this was to vary the water speed in the tunnel. The wave length of the raw signal was proportional to the speed of the water. If the wave length increased as the water speed decreased, the true signal was being received. If the wave length remained constant, the signal was actually the frequency shifter.

When the signal was very weak coming from the photo-multiplier two things helped to improve its visibility. First, if the signal went strictly to the oscilloscope the power was at a maximum. It was much more covenient to use a T connection and have the signal go to both the signal processer and the scope but this reduced the power of the signal and often made it too weak to discern. When even this was not enough, a second alternative was to have the signal go through the signal processer and display the amplified input on the oscilloscope. This was only used when the signal was too weak by itself and the confidence in this signal was much lower than the raw signal.

The oscilloscope could in no way have replaced the optical focusing procedure, but it did assist. After the visual pattern was focused and centered and the photo-multiplier put in place, fine adjustments in centering could be made while watching the signal on the scope. The

best way to go about this was to visually focus using the large aperture mask. This gave a more clearly defined pattern to focus. Before replacing the photomultiplier, the small aperture mask was placed on the receiving optics to reduce the noise and make the signal clearer. Then the centering set screws were adjusted while watching the raw signal on the oscilloscope.

At seven of the sixty-six stations there arose a problem which the author could never resolve. Each of these cases occurred near the leading or trailing edge but most dramatically near the trailing edge. At particular distances from the foil a beam would impinge on the very tip of either the leading or trailing and in essence spray light directly into the focusing optics. This not only made enough noise to drown the signal but made visual focusing hazardous at best. Figures 4 and 5 show this phenomenon. The author believes this was caused by the leading and trailing edges being the least perfect in curvature and thus causing strange optical effects. Vertical movement made no difference, however, so this theory is suspect. The problem was more acute at the trailing edge because of the multiple beams coming from the beam which went through the frequency shifter. These beams came from the upstream side of the laser transmitter, crossed the other beam and then impinged on the foil downstream of the other beam. This meant that the trailing edge had a greater range in which a beam could hit the edge and scatter light into the receiving optics.

FIGURE 4 - Trailing Edge Scattering

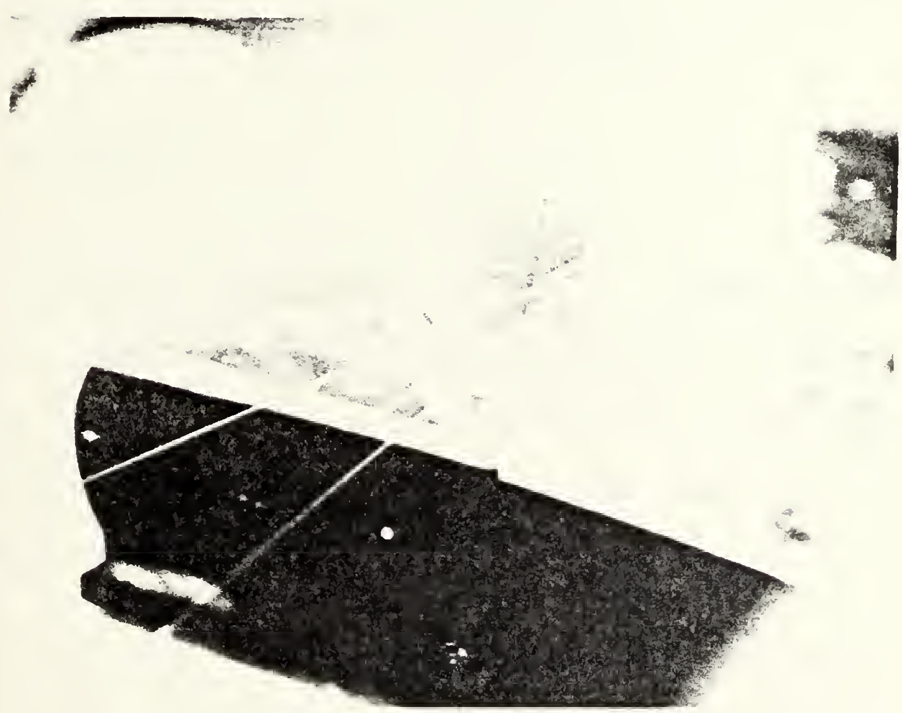

FIGURE 5 - Trailing Edge Scattering

IV. DISCUSSION

The reason for picking an ogival shaped foil was to facilitate the manufacture of the foil and the theoretical calculations. By using a Karman-Trefftz transformation the conformal mapping of a uniform flow around a circle to a uniform flow around the foil shape was realtively easy. A computer program entitled Karman (Treftz) developed by John Hammond for Professor Kerwin made the process of calculating pressure coefficients very easy. The parameters used were circle center coordinates of x = 0.0, y = .105098 and λ = 1.8743593. Figures 6 through 10 show the pressure distributions calculated. The actual data was initially plotted into the velocity profiles shown in figures 11 through 13. The points just outside the boundary layer were determined from these plots and used to calculate the pressure coefficient, C_p, which was defined as

$$C_p = 1 - (U_n)^2$$

where U_n is the nondimensional velocity. Determining where the boundary layer ended was not very distinct at some stations but a best visual estimate was used. The plots of the experimental pressure coefficients are shown in figures 14 through 16.

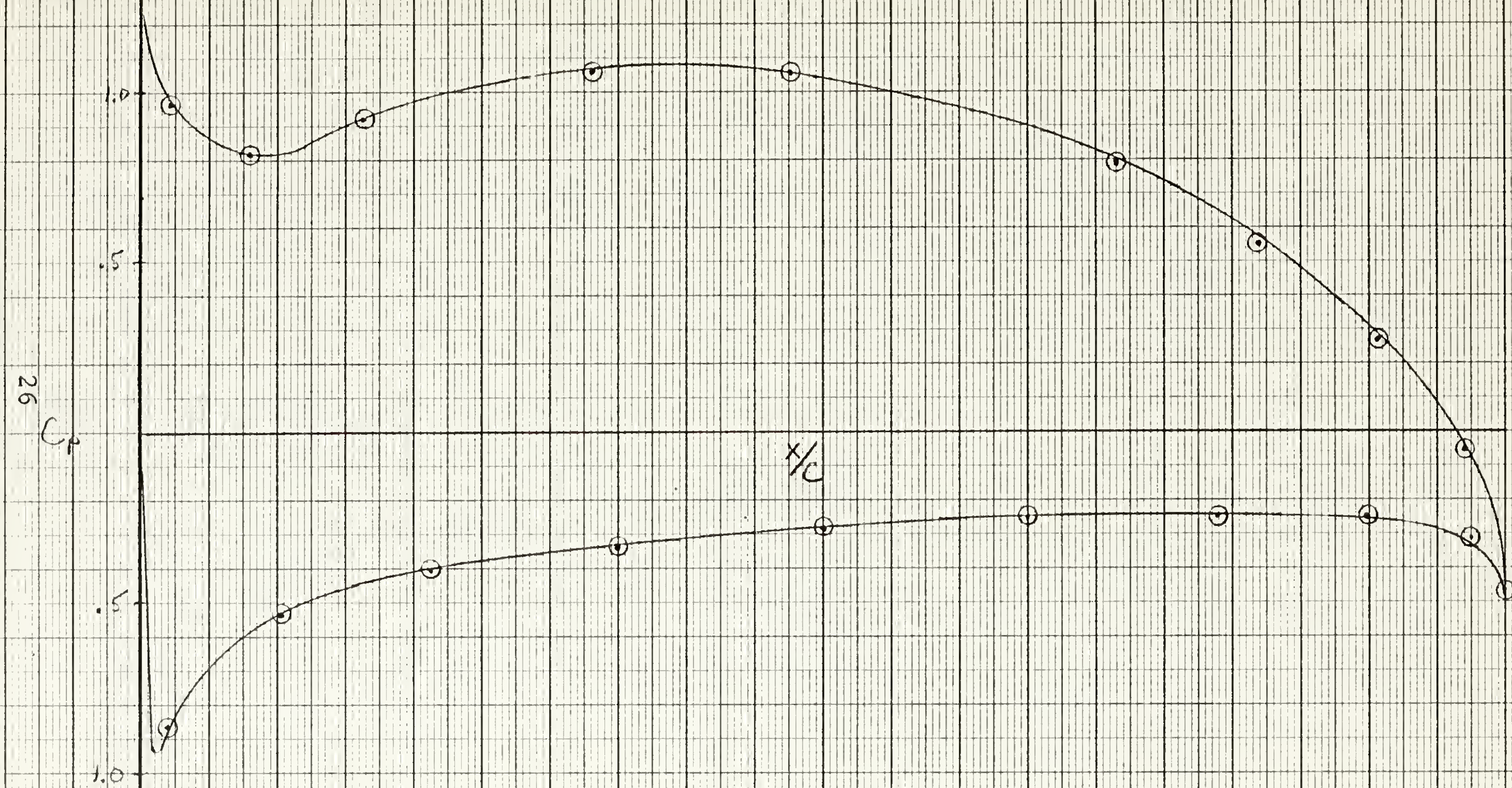

FIGURE 6 - Karman-Trefftz Pressure Distribution, α = +4.0

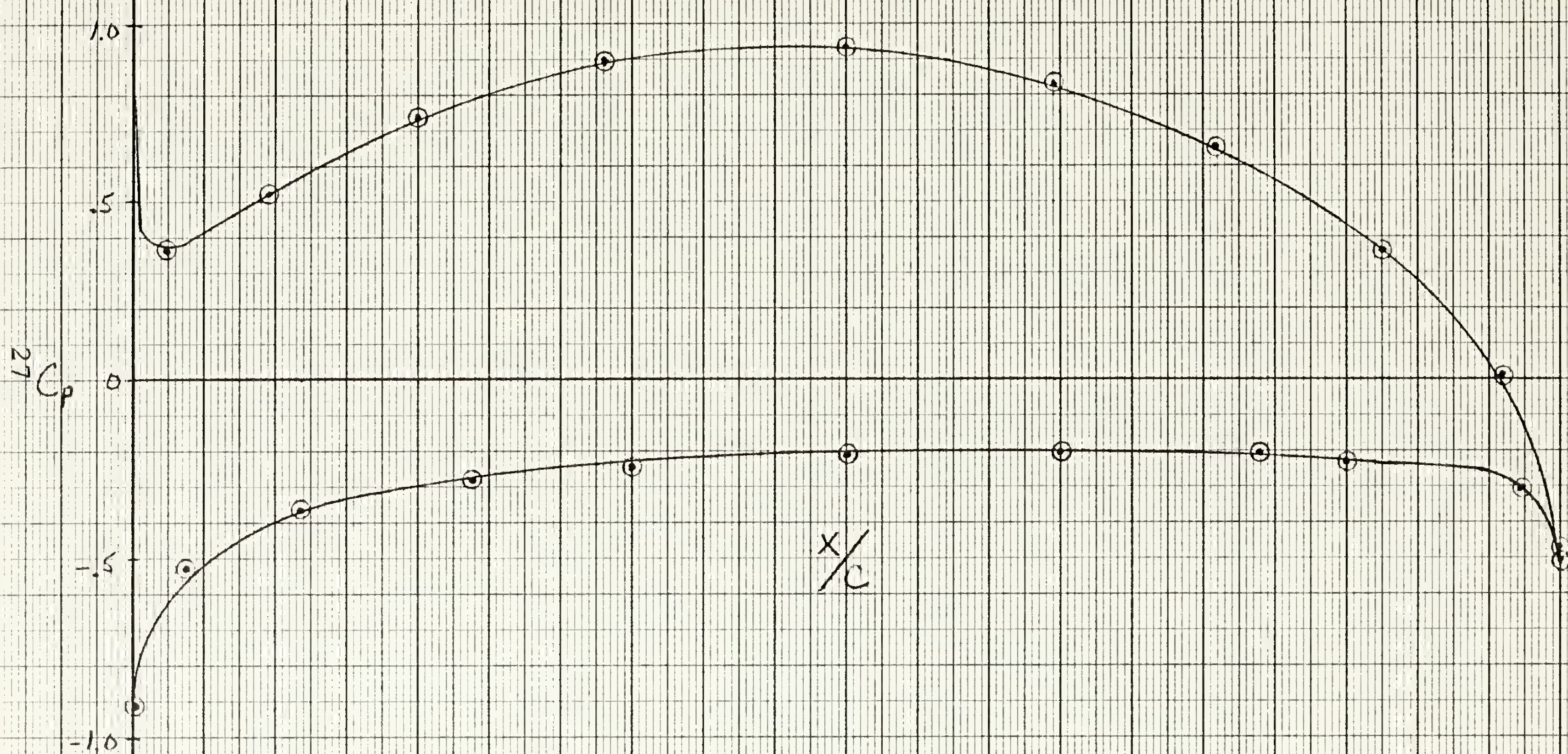

FIGURE 7 - Karman-Trefftz Pressure Distribution, α = +2.0

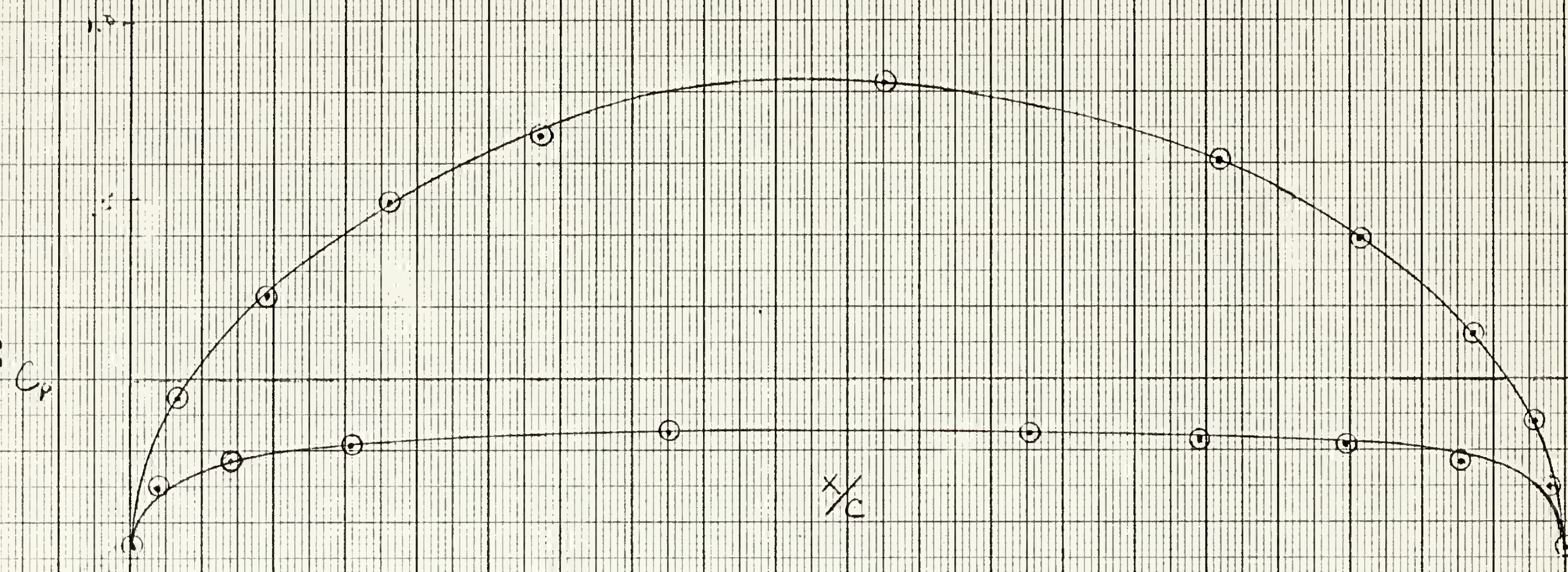

FIGURE 8 - Karman-Trefftz Pressure Distribution, α = 0.0

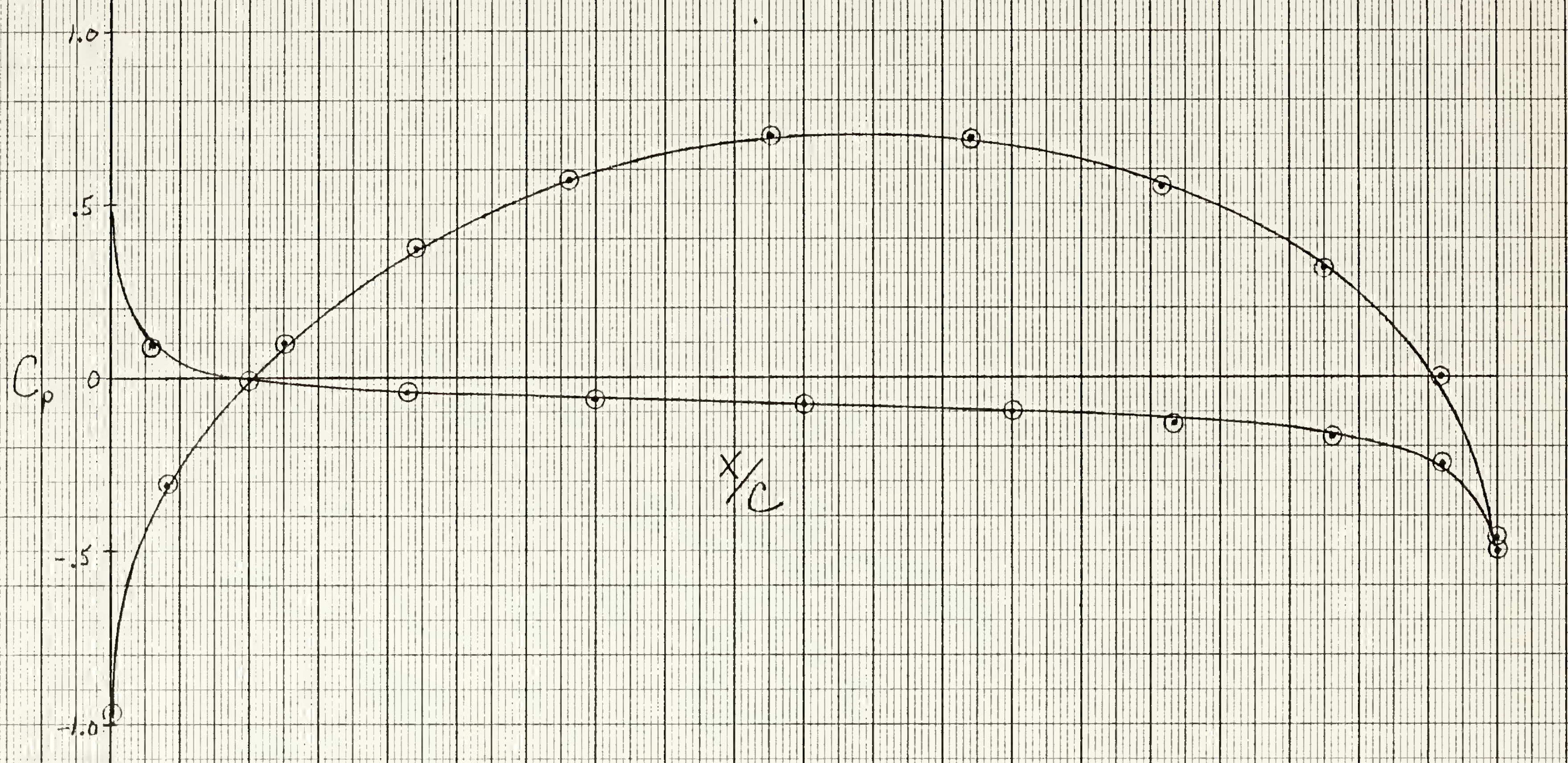

FIGURE 9 - Karman-Trefftz Pressure Distribution, α = -2.0

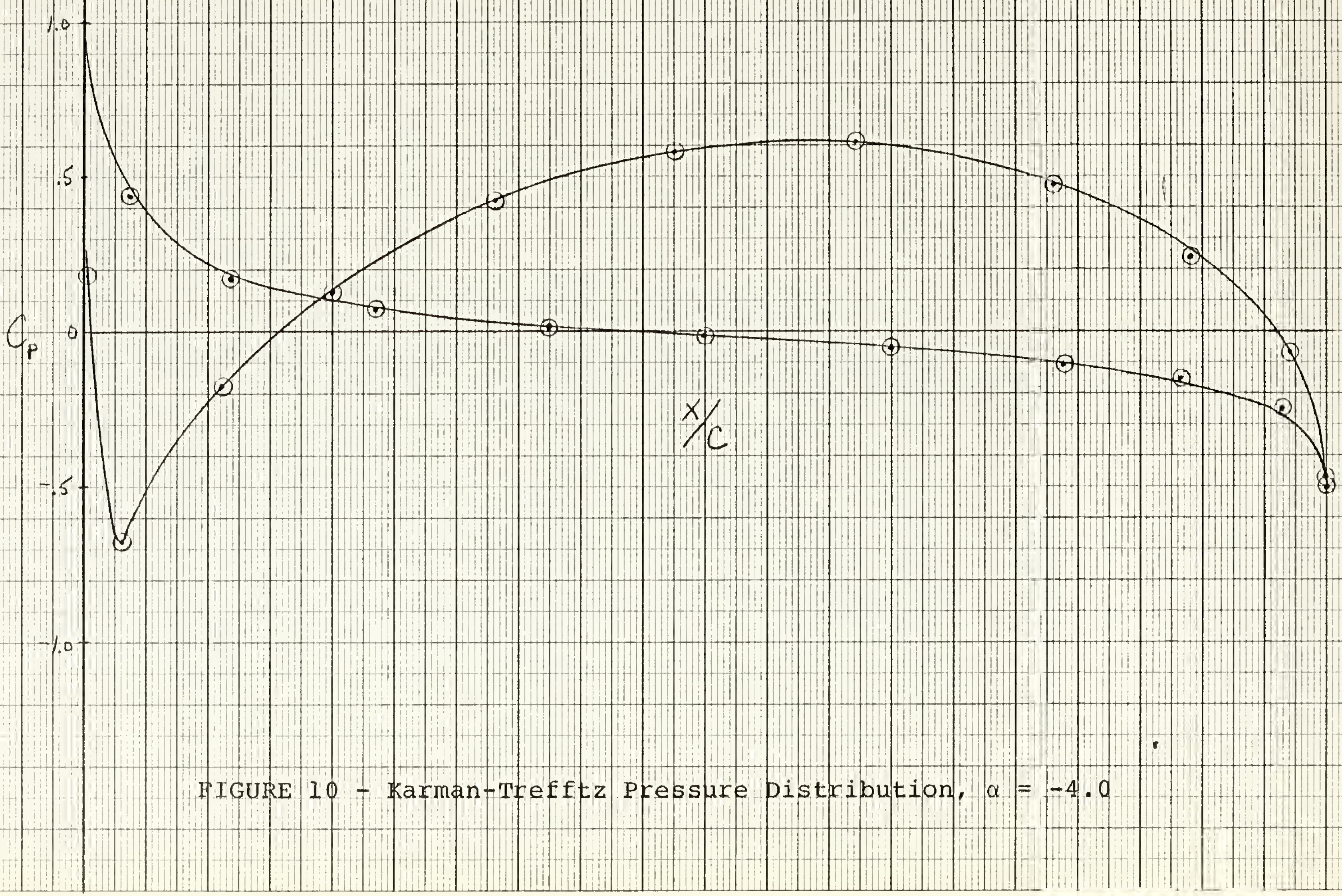

FIGURE 10 - Karman-Trefftz Pressure Distribution, α = -4.0

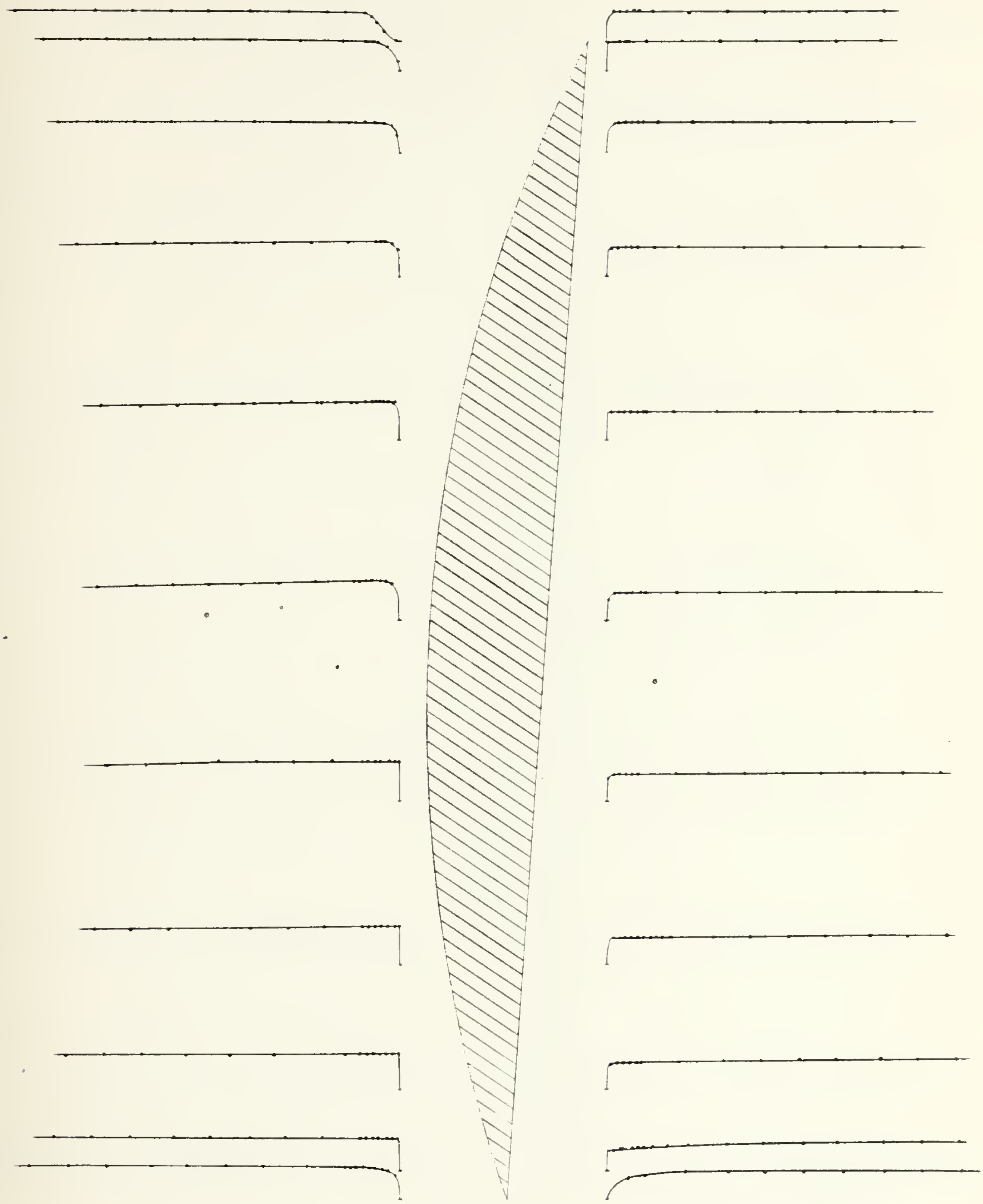

FIGURE 11 - Velocity Profiles, α = +4.0

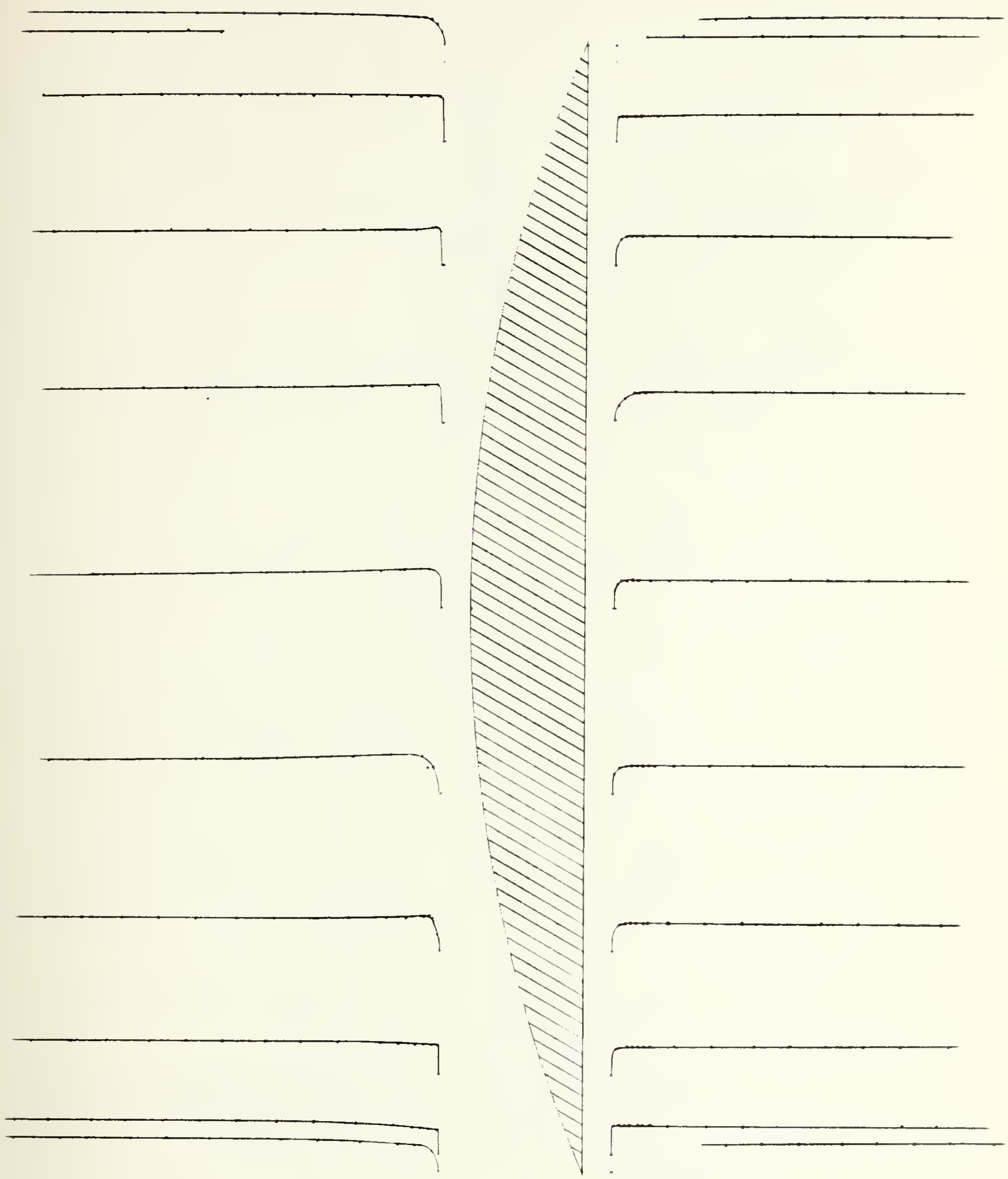

FIGURE 12 - Velocity Profiles, $\alpha = 0.0$

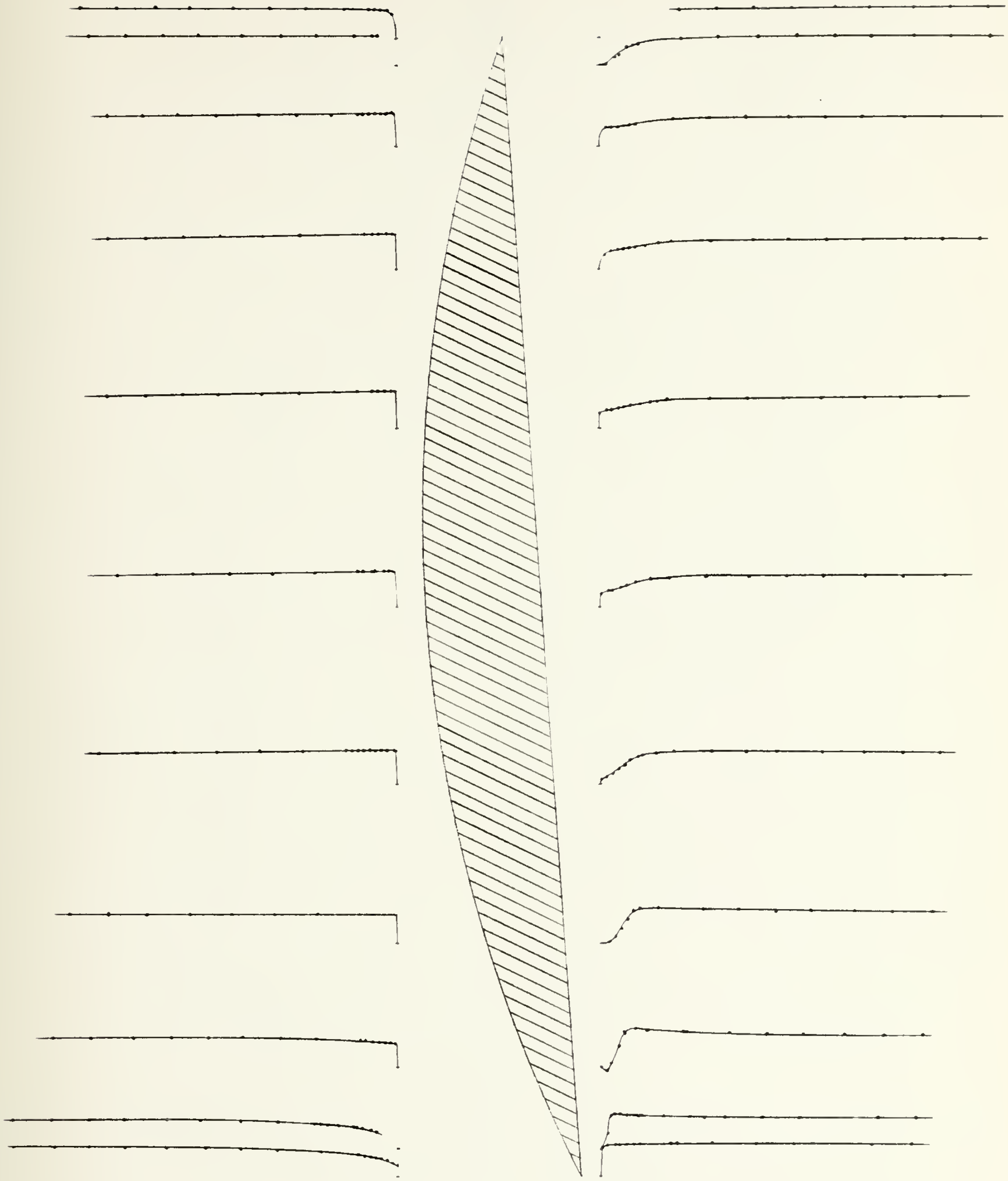

FIGURE 13 - Velocity Profiles, α = -4.0

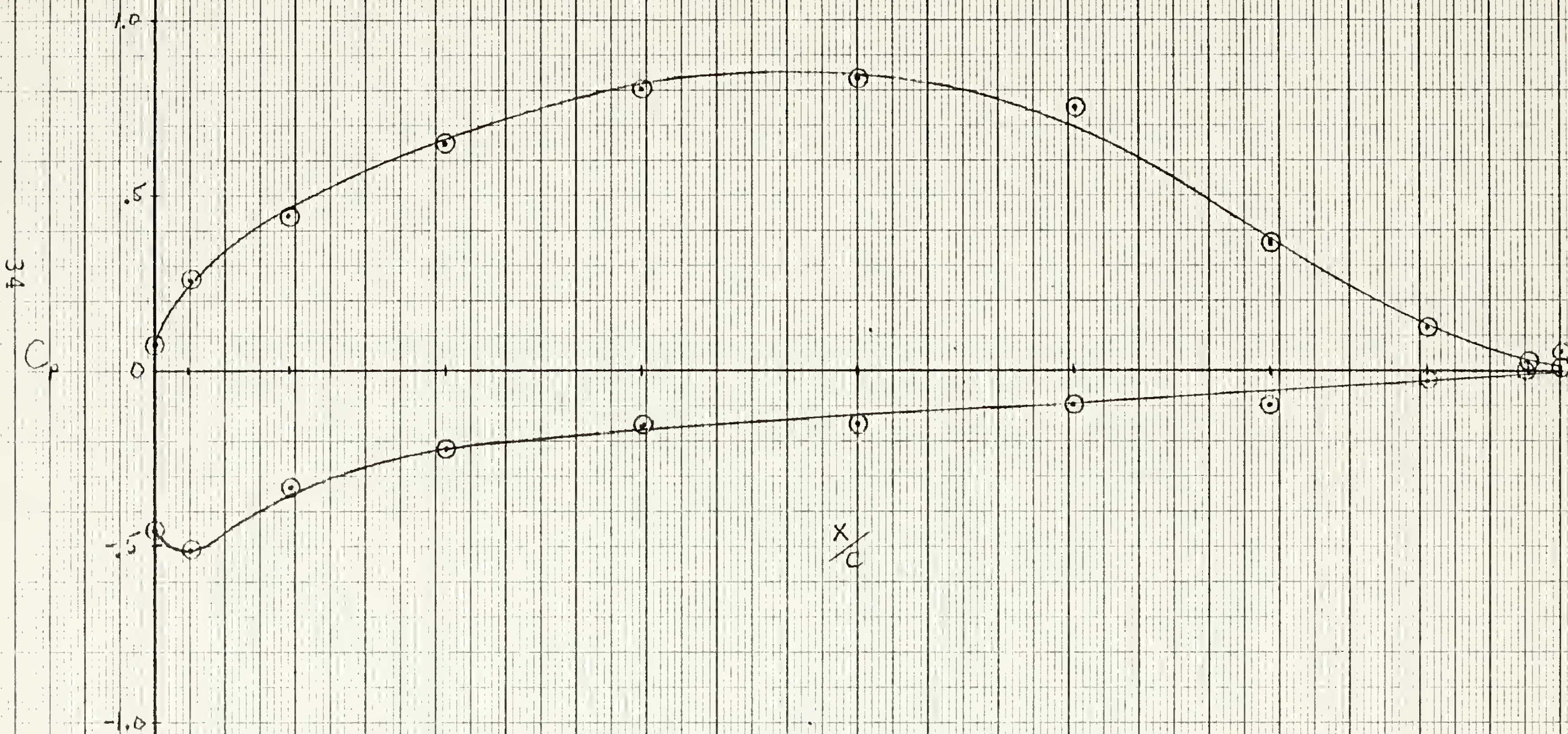

FIGURE 14 - Experiment Pressure Distribution, α = +4.0

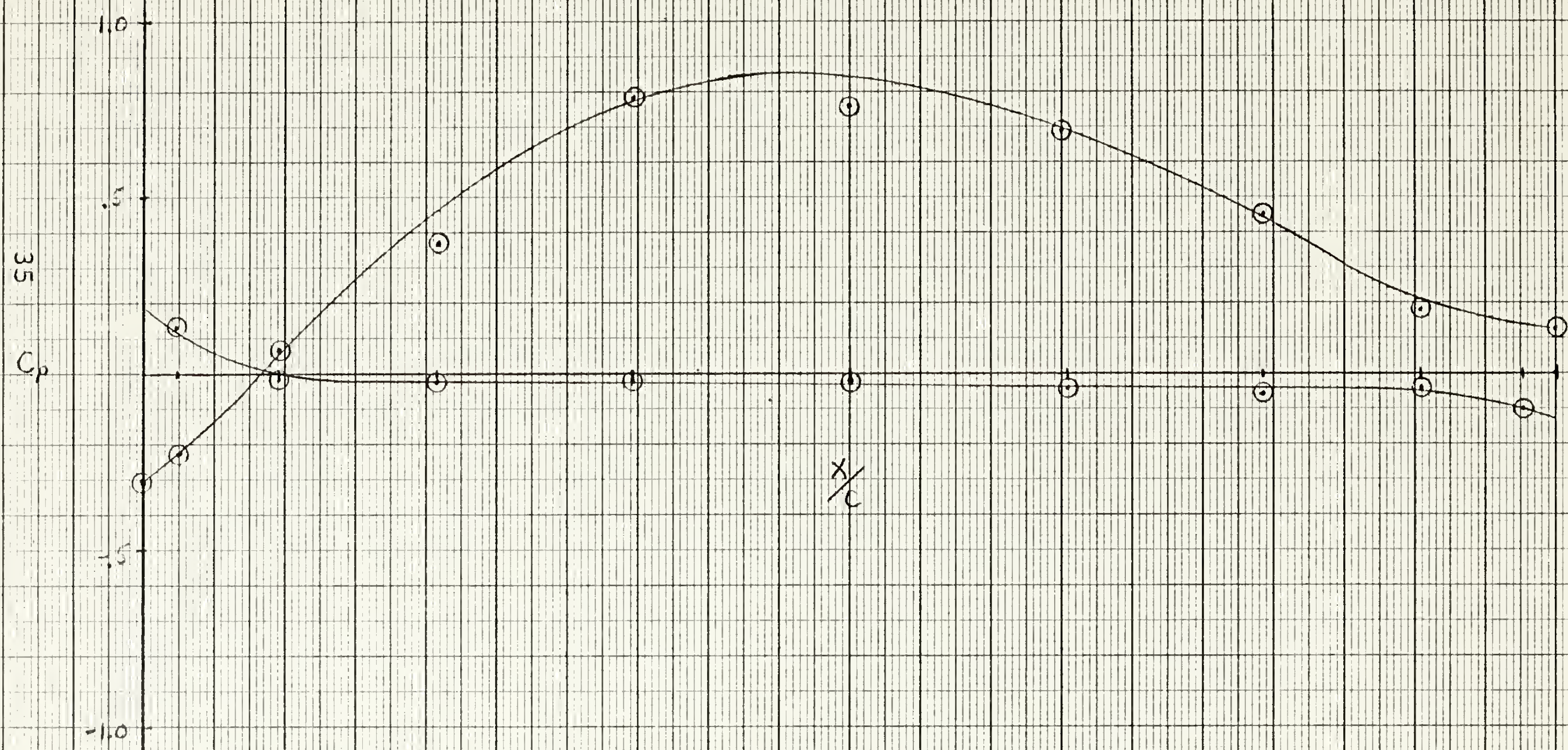

FIGURE 15 - Experimental Pressure Distribution, α = 0.0

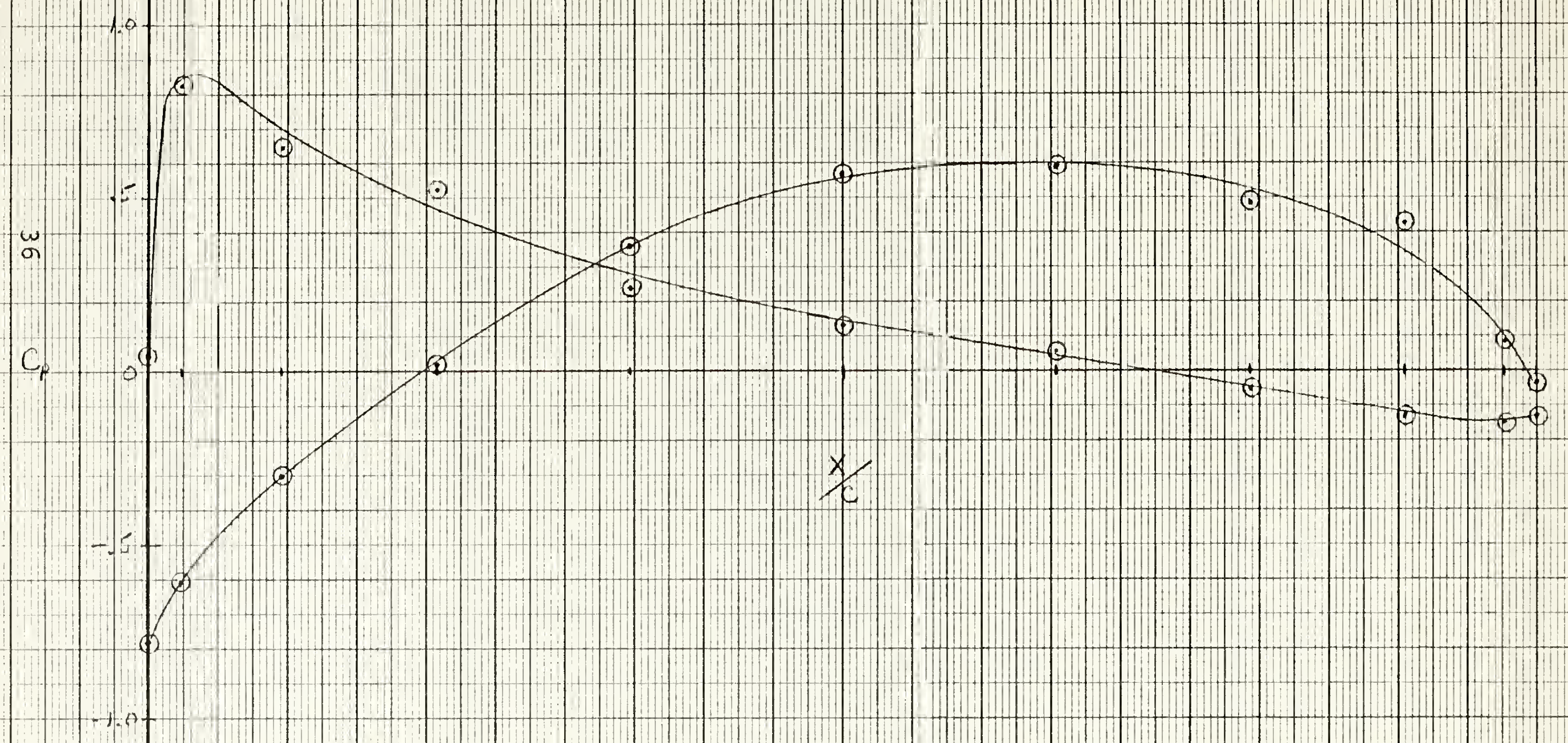

FIGURE 16 - Experimental Pressure Distribution, α = -4.0

Obviously the difference in comparing the theoretical pressure distributions with the experimental is viscous effects. These effects cause approximately a 75 percent reduction in lift as a result of the boundary layer growth. To compare experimental results with the inviscid results, a simple calculation can be made using the approximation

$$C_L = 2\pi\alpha + 4\pi(\frac{f_o}{C})$$

where $2\pi\alpha$ is the flat plate approximation and $4\pi(\frac{f_o}{C})$ is the camber approximation for the linearize problem with $(\frac{f_o}{C})$ being the camber ratio. At zero angle of attack all lift is from camber and any reduction in lift due to viscous effects would appear as an apparent reduction in the angle of attack. A 25 percent reduction would then mean

$$2\pi\alpha' = .25[4\pi(\frac{f_o}{C})]$$

where α' is the apparent reduction angle. For this foil $(\frac{f_o}{C}) = .05$ and thus

$$\alpha' = 1.4°$$

This means that figure 15, $\alpha = 0.0$ of the experimental results should compare with figure 9, $\alpha = -2.0$ of the theoretical results most closely as it does.

The same approximation of C_L can be used to determine the angle of zero lift.

$$C_L = 2\pi\alpha + 4\pi(\frac{f_o}{C}) = 0$$

$$\alpha = -5.7°$$

The experimental results in figure 16, α = -4.0, show close to a zero lift distribution.

The boundary layer growth shown in the velocity profile graphs of figures 11 through 13 is at times inconsistant. This is most likely due to the fact that the closer to the foil the more difficult it was to obtain good data. Therefore, accurate reliable data in the boundary layer was not taken until the learning process with the laser dopler anemometer was completed. However, there are several significant observations to be made on each figure.

In figures 14 and 15, α = +4.0 and 0.0, station 0 shows no distinct boundary layer but a gradual retardation of the flow upon approaching the stagnation point. At station 10 on the convex side of figure 14, α = +4.0, the profile shows the very beginning of backflow around the trailing edge. The figure of most interest is figure 16, α = -4.0. Here both station 0 and station 1 on the convex side show a gradual retardation suggesting the stagnation point is on the upper

surface between the two stations as would be expected. The flat side at station 2 shows a backflow indicating or hinting at the presence of a separation bubble in that region and then reattachment by station 3. The entire flat side of this figure shows a region thicker than the boundary layer should be of retarded flow. Since the laser dopler anemometer gives an average velocity this could be assumed an area of major turbulence.

V. CONCLUSIONS AND RECOMMENDATIONS

This thesis shows that using the laser dopler anemometer and a transparent model is a good method of obtaining accurate and reliable data about the velocity field around the model. The method does require, however, a certain expertise in the operation of the LDA and this can only be gained by experience. The comparison of theoretical calculations and actual data bears out that the technique is a good one. They also show in the case of the boundary layers in the velocity profiles that as the author gained more experience the data became much better. The fabrication of the foil also is very important and the better job done on that, the easier the collection of data would be.

Although this method is adequate, the author recommends that an attempt or detailed analysis be made of collecting the same data with a different foil orientation. By placing the foil in a horizontal position between the two side windows and having the laser beams radiate parallel to the foil span, the need to pass the beams through the foil would be eliminated.

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APPENDIX A

PRESSURE DISTRIBUTION TABLES

TABLE I

Karman-Trefftz Transformation
Calculation of C_p at +4.0 Degrees Angle of Attack

Upper Surface

x/C	C_p
.001	5.464
.023	.965
.079	.821
.162	.920
.331	1.067
.476	1.067
.714	.796
.819	.554
.906	.268
.969	-.051
.999	-.479

Lower Surface

x/C	C_p
0.001	.693
.020	-.873
.102	-.534
.213	-.402
.350	-.327
.500	-.280
.650	-.254
.787	-.244
.898	-.256
.972	-.314
.999	-.521

TABLE II

Karman-Trefftz Transformation
Calculation of C_p at +2.0 Degrees Angle of Attack

<u>Upper Surface</u>

x/C	C_p
.001	1.6767
.023	.3705
.094	.5238
.201	.7437
.331	.9007
.500	.9419
.645	.8374
.758	.6603
.874	.3664
.958	.0132
.999	-.4740

<u>Lower Surface</u>

x/C	C_p
.001	-.9097
.037	-.5339
.118	-.3608
.234	-.2806
.350	-.2424
.500	-.2157
.650	-.2040
.787	-.2071
.898	-.2307
.972	-.2992
.999	-.5146

TABLE III

Karman-Trefftz Transformation
Calculation of C_p at 0.0 Degrees Angle of Attack

Upper Surface

x/C	C_p
.001	-.471
.032	-.054
.094	.238
.181	.487
.286	.680
.524	.826
.758	.611
.856	.393
.934	.126
.977	-.120
.999	-.470

Lower Surface

x/C	C_p
.001	-.470
.019	-.309
.073	-.226
.153	-.186
.375	-.153
.626	-.153
.744	-.164
.847	-.186
.927	-.226
.980	-.306
.999	-.510

TABLE IV

Karman-Trefftz Transformation
Calculation of C_p at -2.0 Degrees Angle of Attack

Upper Surface

x/C	C_p
.001	-.9670
.042	-.3169
.126	.1063
.221	.3772
.331	.5769
.476	.7043
.621	.6961
.758	.5584
.874	.3170
.958	.0005
.999	-.4683

Lower Surface

x/C	C_p
.001	1.8913
.028	.0911
.102	-.0136
.213	-.0450
.350	-.0648
.500	-.0839
.650	-.1064
.766	-.1311
.882	-.1745
.963	-.2531
.999	-.5057

TABLE V

Karman-Trefftz Transformation
Calculation of C_p at -4.0 Degrees Angle of Attack

Upper Surface

x/C	C_p
.001	.1895
.031	-.6760
.110	-.1790
.201	.1372
.331	.4208
.476	.5830
.621	.6092
.779	.4740
.890	.2435
.969	-.0671
.999	-.4674

Lower Surface

x/C	C_p
.001	6.2811
.037	.4404
.118	.1726
.234	.0759
.374	.0193
.500	-.0176
.650	-.0589
.787	-.1041
.882	-.1518
.963	-.2411
.999	-.5030

TABLE VI

C_p for +4.0 Degrees Angle of Attack

Upper Surface

Station	Nondimensional Velocity	C_p
LE	1.0407	.083
1	1.1224	.260
2	1.2027	.446
3	1.2868	.656
4	1.3425	.802
5	1.3557	.838
6	1.3226	.749
7	1.1707	.371
8	1.0616	.127
9	1.0130	.026
TE	1.0086	.017

Lower Surface

Station	Nondimensional Velocity	C_p
LE	.7381	-.455
1	.6996	-.511
2	.8210	-.326
3	.8838	-.219
4	.9186	-.156
5	.9230	-.148
6	.9511	-.095
7	.9516	-.094
8	.9858	-.028
9	.9994	-.001
TE	1.0294	.060

TABLE VII

C_p for 0.0 Degrees Angle of Attack

Upper Surface

Station	Nondimensional Velocity	C_p
LE	.8350	-.303
1	.8777	-.230
2	1.0340	.069
3	1.1703	.370
4	1.3369	.787
5	1.3269	.761
6	1.2999	.690
7	1.2021	.445
8	1.0863	.180
9	--	--
TE	.9335	-.129

Lower Surface

Station	Nondimensional Velocity	C_p
LE	--	--
1	1.0664	.137
2	.9957	-.009
3	.9962	-.008
4	.9935	-.013
5	.9949	-.010
6	.9802	-.039
7	.9696	-.060
8	.9586	-.041
9	.9493	-.099
TE	--	--

TABLE VIII

C_p for -4.0 Degrees Angle of Attack

Upper Surface

Station	Nondimensional Velocity	C_p
LE	.4691	-.780
1	.6286	-.605
2	.8376	-.298
3	1.0129	.026
4	1.1670	.362
5	1.2522	.568
6	1.2605	.589
7	1.2179	.483
8	1.1948	.428
9	1.0420	.086
TE	.9852	-.029

Lower Surface

Station	Nondimensional Velocity	C_p
LE	1.0213	.043
1	1.2230	.829
2	1.2839	.648
3	1.2358	.527
4	1.1133	.239
5	1.0438	.137
6	1.0302	.061
7	.9789	-.042
8	.9328	-.130
9	.9218	-.150
TE	.9338	-.128

APPENDIX B

STATION SPACING

TABLE IX

Station Spacing

Station	Percent Chord
0	0.0
1	2.4
2	9.5
3	20.6
4	34.6
5	50.0
6	65.4
7	79.4
8	90.5
9	97.6
10	100.0

APPENDIX C

RAW DATA

1 of 1

Date 2 Nov 1977 Test No. 2

Angle of Attack 0.0

Water Temp 73 Room Temp 73 Manometer Tubes 7/4

Station 5

Lens distance from Window 7 1/2

Initial Pointer Reading 20.53

8.60 Pointer Reading on foil ~~11.75~~ 11.40

Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
20.53	12.183	606.9	10.1172	861.0		1.1407	
19.95	11.413	606.1	10.1125	[illegible]		1.1446	
18.91	10.025	609.5	10.1408	871.9		1.1529	
17.90	8.677	609.8	10.1442	881.5		1.1652	
16.92	7.369	604.6	10.1000	888.0		1.1737	
15.98	6.114	[illegible]	10.1100	899.2		1.1734	
15.33	4.306	607.3	10.1225	915.7		1.2130	
13.91	3.351	606.5	10.1158	935.0		1.2374	
12.92	2.107	607.3	10.1225	962.3		1.2754	
12.49	1.455	605.4	10.1067	973.6		1.2920	
12.05	.901	606.2	10.1133	991.3		1.3150	
~~11.55~~				~~[illegible]~~			Lost Track
11.50	.133	[illegible]	10.1292	[illegible]		1.2031	
[illegible]	.734	607.5	10.1242	[illegible]		1.3144	
11.72	.400	607.2	10.1217	1001.6		1.3269	
11.60	.267	[illegible]	10.1283	[illegible]		1.2123	
11.29	[illegible]	608.0	10.1283	837.7		[illegible]	Flutter

Date 2 NOV 1977 Test No. 3

Angle of Attack 0.0

Water Temp 79 Room Temp 76 Manometer Tubes 7/4

Station 4

Lens distance from Window $7\frac{22}{32}$

Initial Pointer Reading 20.97

9.56 on foil Pointer Reading ~~11.11~~ 10.70

Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
20.97	12.709	606.6	10.1167	849.7		1.1262	
19.93	12.321	607.8	10.1267	855.1		1.1323	
18.82	10.839	606.5	10.1158	860.6		1.1408	
17.89	9.578	606.5	10.1158	867.4		1.1498	
16.93	8.316	604.4	10.0831	875.3		1.1640	
15.95	7.008	607.8	10.1267	884.2		1.1703	
14.77	5.727	608.1	10.1292	897.2		1.1877	
13.91	4.385	610.0	10.1450	918.7		1.2143	
12.98	3.044	609.9	10.1442	958.9		1.2675	
12.00	1.735	610.4	10.1432	1021.8		1.3501	
11.01	.414	612.3	10.1642	679.2		.8962	
10.89	.254	613.7	10.1775	681.4		.8978	
10.69	-.013						IN FOIL
11.17	.627	613.2	10.1717	1014.1		1.3367	
11.08	.507	613.1	10.1702	1015.1		[illegible]	
						1.3333	

Date 3 Nov 1977 Test No. 4A

Angle of Attack 0.0

Water Temp 80 Room Temp 81 Manometer Tubes 7/4

Station 3

Lens distance from Window 7 25/32

Initial Pointer Reading 20.97

on foil 10.60

Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
~~14.94~~		~~609.3~~		~~924.4~~			Manual
7.35 → ~~13.92~~		~~603.2~~		~~774.0~~			"
~~13.92~~		~~604.7~~		~~925.2~~			"
13.92	4.432	611.1	10.1542	863.5		1.1403	Good data
12.96	3.150	610.0	10.1450	863.8		1.1417	"
14.95	5.707	610.1	10.1453	858.9		1.1351	
15.93	7.115	609.9	10.1442	853.9		1.1287	
16.99	8.530	610.2	10.1417	851.2		1.1247	
17.97	9.838	609.8	10.1433	859.2		1.1358	
18.95	11.146	610.4	10.1433	849.0		1.1313	
20.00	12.542	610.1	10.1458	829.0		1.0756	
* 20.97	13.343	601.5	10.0737	826.5		1.1001	
12.94	3.124	607.2	10.1333	864.4		1.1433	
12.01	1.[illegible]	607.7	10.1425	873.6		1.1550	
~~11.52~~	—	~~607.2~~	—	~~[illegible]~~			
11.52	1.338	6[illegible]6.7	10.1353	875.4		1.1531	
11.03	.574	607.5	10.1242	[illegible]		1.1703	

Date 3 NOV 1977 Test No. 4A

Angle of Attack 0.0

Water Temp 80 Room Temp 81 Manometer Tubes 7/4

Station 3

Lens distance from Window 7 25/32

Initial Pointer Reading 20.97

on foil 10.60

Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
10.41							IN FOIL
11.00	.534	608.0	10.1233	879.7		1.1646	
10.86	.347	606.8	10.1183	899.5		1.1920	?
10.86	.347	608.3	10.1303	877.8		1.1613	
10.78	.240	607.6	10.1250	839.3		1.1115	
10.78	.240	607.6	10.1250	856.1	- better Avg over time		1.1338
10.72	.16	608.4	10.1317	430.2		.5694	
10.69	.120	608.4	10.1317	423.4		.5604	
10.58							IN FOIL

Date 3 NOV 1977 Test No. 5

Angle of Attack 0.0

Water Temp 80 Room Temp 81 Manometer Tubes 7/4

Station 2

Lens distance from Window $7\frac{26}{32}$

Initial Pointer Reading 20.96

ON Foil 10.20

	Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.96	14.330	596.3	10.0297	824.5		1.1023	
	19.93	12.855	595.8	10.0254	826.4		1.1052	
	18.99	11.600	595.7	10.0246	825.4		1.1041	
	17.39	10.132	596.0	10.0271	829.2		1.1027	
	16.92	8.837	590.0	9.9761	816.0		1.1102	
	15.97	7.569	594.2	10.0117	822.3		1.1013	
RF	14.85	6.074	594.1	10.0110	813.7		1.0966	
RF	13.90	4.806	595.9	10.0263	813.7		1.0882	
	12.96	3.551	594.1	10.0110	804.5		1.0776	
RF	11.86	2.082	591.5	9.9239	739.1		1.0593	
RF	11.38	1.442	594.2	10.0119	732.1		1.0475	
	10.92	.828	590.8	9.9527	773.1		1.0384	
	10.92	.533	591.1	9.9355	771.9		1.0365	
	10.73	.374	590.4	9.9725	[illegible]		1.0319	
	10.49	.254	591.3	9.9715	770.5		1.0340	
	10.37	.073	590.6	[illegible]	767.5		1.0311	
	10.22							" foil
RF	17.97	10.265	591.5	9.9?21	820.5		1.1014	

Date 3 NOV 1977 Test No. 6

Angle of Attack 0.0

Water Temp 80 Room Temp 78 Manometer Tubes 7/4

Station 1

Lens distance from Window $6\frac{21}{32}$ $7\frac{25}{32}$

Initial Pointer Reading 17.99 20.85

on foil 9.70

	Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.85	14.884	596.0	10.0271	816.5		1.0917	
	19.94	13.669	599.0	10.0525	819.1		1.0926	
	18.83	12.188	597.3	10.0381	815.5		1.0894	
RF	17.90	10.946	596.8	10.0334	813.1		1.0866	
RF	16.94	9.665	598.8	10.0503	814.0		1.0860	
	15.98	8.323	596.1	10.0290	808.2		1.0807	
RF	15.02	7.102	596.3	10.0297	801.6		1.0717	
RF	13.93	5.647	597.6	10.0407	788.4		1.0529	
	12.93	4.378	596.6	10.0322	777.3		1.0387	
RF	11.37	2.897	598.3	10.0502	751.8		1.0030	
RF	10.90	1.602	596.6	10.0322	713.3		.9534	
	10.43	.974	596.2	10.0233	671.9		.8734	
RF	9.94	.324	598.2	10.0508	630.8		.8416	
	10.16	.614	597.3	10.0424	657.3		.8777	
	9.73	.040	596.9	10.0347	613. .		.8266	
	9.68							IN FOIL

Date 3 NOV 1977 Test No. 7

Angle of Attack 0.0

Water Temp 21 Room Temp 20 Manometer Tubes 7/4

Station 0 (Test ahead of LE)

Lens distance from Window $7\frac{27}{32}$

Initial Pointer Reading 20.98

on fo.1 9.80 11.12

	Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.98	14.924	594.4	10.0136	813.5		1.0893	
	19.79	13.336	591.4	9.9830	809.0		1.0261	
	19.01	12.294	590.8	9.9227	810.3		1.0394	
	17.88	10.736	598.3	10.0466	811.5		1.0331	
	16.94	9.531	596.8	10.0339	807.7		1.0794	
	15.83	8.047	596.0	10.0271	801.6		1.0720	
	14.89	6.795	593.3	10.0042	795.0		1.0656	
	13.92	5.500	596.8	10.0339	786.0		1.0504	
	12.97	4.232	595.5	10.0229	773.6		1.0349	
	11.88	2.777	595.1	10.0195	745.7		.9920	
RF	10.90	1.468	597.1	10.0364	707.9		.9458	
	10.44	.854	599.9	10.0602	680.9		.9076	
	9.96	.214	598.2	10.0458	625.6		.8350	
	9.45	-.427	598.7	10.0517	584.6		.7779	
	9.01	-1.055	598.8	10.0508	731.1		.9754	
	9.30	-.667	597.7	10.0535	675.8		.9009	
	9.41	-.521	597.7	10.0415	610.4		.8151	
	9.68	-.160	593.6	10.0376	582.4		.7765	

Date 3 Nov 1977 Test No. 8

Angle of Attack 0.0

Water Temp 21 Room Temp 81 Manometer Tubes 7/4

Station 6

Lens distance from Window $7\frac{28}{32}$

Initial Pointer Reading 20.98

Move ¼" higher to avoid scratch on window on foil 11.00

	Pointer	Distance from Wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.98	13.322	601.8	10.0763	854.1		1.1366	
	19.94	11.934	602.1	10.0788	861.0		1.1455	
	18.34	10.4??	601.8	10.0763	867.2		1.1540	
RF	17.73	8.934	602.2	10.0797	874.0		1.1627	
	16.92	7.703	604.0	10.0949	884.3		1.1746	
RF	15.81	6.421	603.9	10.0941	891.7		1.1845	
	14.89	5.193	604.0	10.0949	903.8		1.2005	
	13.91	3.835	602.9	10.0856	917.2		1.2221	
	12.80	2.403	604.3	10.1017	937.1		1.2466	
	11.85	1.135	605.4	10.1067	962.3		1.2731	
	11.41	.547	605.3	10.1058	977.0		1.2963	
	11.12	.160	605.8	10.1100	980.1		1.2999	
	10.96	-.053						IN FOIL

Date 4 NOV 1977 Test No. 9

Angle of Attack 0.0

Water Temp 81 Room Temp 79 Manometer Tubes 7/4

Station 7

Lens distance from Window 7 3/32

Initial Pointer Reading 20.97

on foil 10.78

	Pointer	Distance from Wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.97	13.603	601.9	10.0771	836.2		1.1127	
	19.59	12.161	601.2	10.0712	840.6		1.1192	
	18.83	10.746	603.9	10.0741	847.5		1.1258	
	17.39	9.491	601.5	10.0737	874.4		1.1637	
RF	16.72	8.196	609.4	10.1400	856.3		1.1324	
	15.22	6.728	609.0	10.1367	864.0		1.1429	
	17.96	9.525	613.9	10.1775	856.4		1.1283	
	14.33	5.473	612.2	10.1633	861.5		1.1366	
RF	13.91	4.178	603.2	10.0831	870.0		1.1564	
RF	12.94	2.223	[illegible]	10.1167	877.8		1.1635	
F	12.71	1.642	603.1	10.0773	895.1		1.1797	
	11.51	.974	603.9	10.0741	901.5		1.1776	
	11.05	.360	[illegible]	10.0831	915.1		1.2163	
	10.78	.267	609.9	10.1442	[illegible]		1.2021	
	[illegible]	.027	[illegible]	10.1133	[illegible]		1.1014	
	10.75							IN FOIL

Date 4 NOV 1977 Test No. 10

Angle of Attack 0.0

Water Temp 81 Room Temp 79 Manometer Tubes 7/4

Station 2

Lens distance from Window $7 \frac{26}{32}$

Initial Pointer Reading 20.98

Raised $\frac{1}{4}$" to avoid imperfection on foil on foil 10.50

	Pointer	Distance from Wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.98	13.990	599.2	10.0593	831.4		1.1083	
	19.96	12.628	600.1	10.0619	822.4		1.0960	
	18.99	11.333	599.8	10.05[illegible]	811.5		1.0217	?
RF	17.88	9.852	599.8	10.0573	834.9		1.1129	
	18.93	11.253	599.7	10.0602	835.5		1.1136	
	16.92	3.570	600.4	10.0644	833.2		1.1101	
=	15.82	7.102	600.5	10.0653	837.0		1.1151	
	14.88	5.347	601.2	10.0712	835.1		1.1119	
RF	13.91	4.552	600.0	10.0610	835.1		1.1130	
	12.95	3.271	600.2	10.0627	832.7		1.1096	
RF	12.00	2.002	[illegible]1.1	10.0703	826.7		1.1010	
	11.39	1.133	601.8	10.0763	822.8		1.0963	
=	10.92	.561	601.7	10.0771	[illegible]		1.0865	
	[illegible].11	.314	[illegible]	10.0729	816.0		1.0363	
	10.[illegible]0	.133	601.8	10.0763	[illegible]		1.0717	
	10.41							IN FOIL

Date 4 NOV 1977 Test No. 11

Angle of Attack 0.0

Water Temp 81 Room Temp 79 Manometer Tubes 7/4

Station 9

Lens distance from Window $7\frac{25}{32}$

Initial Pointer Reading 20.98 (10.83)

Raised foil ¼ to avoid imperfection on foil on foil 10.15

	Pointer	Distance from wall	Manometer	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	20.98	14.457	600.5	10.0653	320.7		1.0936	
	19.94	13.069	600.1	10.0619	323.4		1.0973	
	18.84	11.600	600.3	10.0672	321.4		1.0940	
	17.89	10.332	600.4	10.0644	313.6		1.0906	
RF	16.88	8.784	593.0	10.0441	357.7	—	1.1477	Stronger ? refraction
RC	15.99	7.796	59[illegible]	10.0339	799.7		1.0637	
	14.87	6.301						

Date 12 Feb Test No. 12 A

Angle of Attack 0.0 Side Convex

Water Temp ____ Room Temp ____ ~~Manometer~~ Tubes ____

Station TE (Just aft)

Lens distance from Window on Foil

Initial Pointer Reading 30.69

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point
39.98	12.401	158.3		822.0		1.1012
39.00	11.073	157.7		816.3		1.0977
38.03	9.793	157.5		814.5		1.0967
37.10	8.557	157.4		811.9		1.0937
36.00	7.038	157.3		806.2		1.0869
35.01	5.767	157.3		799.0		1.0772
34.07	4.512	157.5		790.2		1.0648
33.11	3.230	157.7		775.3		1.0426
32.12	1.937	157.7		749.2		1.0076
31.70	1.348	157.9		728.7		.9787
31.52	1.107	158.0		720.2		.9666
31.38	.921	157.9		710.1		.9537
31.20	.681	158.0		695.5		.9335
31.04	.467	158.2		647.5		.8707
30.90	.280	158.2		495.9		.6618
30.72	.040	152.4		294.3		.3940
30.60	-.120	155.4		458.4		.6137
30.41	-.374	158.4		556.3		.7448
30.26	-.574	158.4		642.7		.8353

Date 31 Jan Test No. 14

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station LE

~~Lens distance from Window~~ on foil surface

Initial Pointer Reading 29.77

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	29.99	.000	160.1		No track			
	30.16	.227	160.2		297.9		.3970	?
	30.38	.521				unable	to track	bubbled
	31.02	1.395				[illegible]	[illegible]	appearance
RF	39.98	13.336	160.7		760.2		1.0026	
	38.25	11.327	160.7		760.7		1.0039	
	37.90	10.559	160.2		760.8		1.0034	
	36.94	9.278	160.9		759.3		1.0002	
	36.00	8.023	160.8		756.1		.9972	
	34.88	6.528	160.7		753.3		.9935	
	33.92	5.246	160.9		750.6		.9873	
	32.99	4.005	161.0		745.7		.9825	
RF	33.01	From	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]				

Date 31 Jan Test No. 15

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station TE

~~Lens distance from Window~~ on foil Surface

Initial Pointer Reading 30.45

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.13	12.922	161.4		759.6		.9931	
	38.85	11.213	161.5		758.1		.9955	
	37.90	9.945	161.4		754.6		.9915	
	36.96	8.690	161.4		752.6		.9339	
	35.22	7.182	161.5		746.7		.9805	
	34.90	5.940	161.7		738.0		.9679	
	33.94	4.659	161.5		726.3		.9537	
	33.00	3.404	161.6		705.0		.9252	
RF	32.01	Same as with test 14. The [illegible]						
	to just [illegible] the [illegible] became [illegible]							
	To the edge [illegible] quite [illegible]							

Date ~~31 Jan~~ & 1 Feb Test No. 16

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 9

~~Lens distance from Window~~ on foil surface

Initial Pointer Reading ~~30.72~~ 32.21

	Pointer	Distance from Wall	~~[illegible]~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.63	11.240	161.4		759.1		.9974	
RF	39.65	9.932	161.5		759.3		.9970	
RF	38.52	8.423	161.7		748.7		.9819	
RF	37.28	6.768	162.1		750.7		.9824	
RF	36.00	5.059	162.9		752.7		.9799	
RF	34.89	could not	get	signal				1 Feb
	33.93	2.296	157.5		708.9		.9545	Did NOT RF
	33.93	2.296	162.0		723.5		.9536	
RF	33.00	1.055	160.8		719.8		.9493	
	32.01			Non dim Vel				IN Foil
RF	32.74	.708	160.3	.7046	532.6			[illegible]
	32.68	.627	160.2	.7101	536.4			
	32.50	.337	160.2	.6823	515.8	questionable points [illegible] noise		
	32.34	.174	160.4	.6477	489.9	[illegible]		
	32.24	.241	157.7	.5241	393.7			Looks like Noise

Date 1 Feb   Test No. 17

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 8

Lens distance from Window on foil

Initial Pointer Reading 32.25

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	41.11	11.827	158.7		751.4		1.0041	Great Signal
	40.01	10.359	158.8		742.9		.9921	
RF	39.08	9.117	159.0		745.5		.9943	great looking [illegible] pattern?
RF	38.07	7.796	159.4		740.7		.9854	
RF	37.00	6.341	160.0		747.6		.9909	
	36.03	5.046	160.0		734.3		.9733	
RF	35.09	3.791	160.3		739.6		.9734	
	34.00	2.336	160.8		731.8		.9651	
	33.34	1.455	160.9		730.4		.9627	
RF	32.85	.841	161.3		727.0		.9558	
	32.71	.614	161.5		731.2		.9601	
	32.53	.374	161.8		731.4		.9586	
	32.40	.200	161.5		717.6		.9423	
	32.30	.067	161.5		710.2		.9326	
	32.25	0.000	161.6		721.0		.9227	
						¼ turn	lost track	
						but could	regain	[illegible]

Date 1 Feb Test No. 18

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 7

Lens distance from Window on foil

Initial Pointer Reading 32.00

	Pointer	Distance from wall	Manometer RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.12	10.339	158.0		742.3		.9963	
	39.08	9.451	158.1		739.0		.9913	
	38.09	8.130	158.0		736.9		.9891	
RF	37.17	6.901	157.8		740.0		.9945	
	36.04	5.393	157.9		729.8		.9802	
RF	35.09	4.125	158.1		734.4		.9851	
	34.15	2.870	158.1		733.7		.9841	
RF	33.02	1.362	158.1		727.2		.9754	
RF	32.73	.974	158.1		729.5		.9785	
	32.54	.721	158.1		726.2		.9741	
RF	32.41	.547	158.2		723.3		.9696	
	32.25	.334	158.0		714.0		.9533	
	32.09	.120	158.0		648.3		.8701	
	31.94	-.080	158.1		535.9		[illegible]	? [illegible]
							.7188	

Date 1 Feb Test No. 19

Angle of Attack 0.0 flat

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station 6

Lens distance from Window on foil

Initial Pointer Reading 31.64

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.13	11.587	158.3		745.1		.9982	
	39.07	10.172	158.3		746.4		.9997	
	38.08	8.850	158.4		744.6		.9969	
	37.15	7.607	158.2		744.2		.9976	
	36.04	6.127	158.3		730.5		.9786	
RF	35.10	4.272	158.4		742.7		.9943	[illegible]
	33.77	3.391	158.2		755.8		1.0131	[illegible]
	33.02	2.109	158.2		753.4		1.0099	
[illegible]	32.42	1.295	158.2		732.6		.9320	Good
	32.26	1.081	158.2		731.2		.9302	Good
	32.07	.354	158.2		727.3		.9749	
RF	31.92	.627	158.2		671.7		.9772	
	31.72	.360	158.2		570.1		.7642	
	31.53	.107	158.1		409.0		.5436	[illegible]
								[illegible]

Date 1 Feb   Test No. 20

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 5

Lens distance from Window on foil

Initial Pointer Reading 31.45

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.15	11.614	158.3		750.0		1.0047	
	39.08	10.185	158.4		750.3		1.0045	
	38.11	8.890	158.4		751.5		1.0061	
	37.01	7.422	158.5		753.5		1.0082	
	36.05	6.141	158.2		755.1		1.0122	
RF	34.93	4.645	158.2		743.3		.9964	
	34.00	3.404	158.2		741.9		.9945	
	32.89	1.922	158.2		738.1		.9394	
	32.41	1.282	158.2		731.6		.9807	
RF	32.10	.868	158.3		741.3		.9938	
	31.94	.654	158.2		742.2		.9949	
	31.78	.441	158.4		738.4		.9386	
	31.63	.240	158.4		709.0		.9492	
	31.45	.013	"		652.0		.8735	[illegible] Manual
RF	31.46	.013	158.2		610.6		.8130	Reading

Date 1 Feb Test No. 21

Angle of Attack 0.0

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 4

Lens distance from Window on foil

Initial Pointer Reading 31.46

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.14	11.587	158.2		747.6		1.0022	
	39.08	10.172	158.3		746.7		1.0003	
	37.92	8.704	158.2		744.1		.9975	
RF	37.00	7.395	158.2		744.7		.9983	
RF	36.05	6.127	158.3		745.4		.9926	
	35.10	4.857	158.2		739.0		.9906	
RF	34.00	3.371	158.5		745.0		.9968	
	33.04	2.109	158.5		739.3		.9392	
RF	32.55	1.455	158.3		741.8		.9938	
	32.40	1.255	157.9		740.4		.9944	
	32.23	1.028	157.8		740.0		.9945	
	32.09	.841	157.7		740.1		.9952	
	31.92	.614	157.6		[illegible]		.9935	
	31.77	.414	157.5		732.1		.9357	
	31.61	.200	157.5		688.0		.9264	
	31.46	.000	157.5		575.3		.7746	

Date 2 Feb Test No. 22

Angle of Attack 0.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 3

Lens distance from Window on foil

Initial Pointer Reading 31.59

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.16	11.440	159.5		755.6		1.0046	
RF	39.08	9.998	159.8		755.5		1.0026	
	37.99	8.543	159.8		761.6		1.0107	
RF	37.01	7.235	159.8		754.1		1.0007	
	36.05	5.954	160.0		733.7		.9725	?
RF	34.97	4.512	159.7		755.5		1.0020	
	34.00	3.217	159.9		754.5		1.0007	
RF	33.03	1.922	160.1		754.7		.9997	
	32.51	1.228	160.2		755.0		.9994	
	32.42	1.102	160.2		753.4		.9973	
	32.25	.881	160.1		752.1		.9962	
	32.07	.667	160.2		752.2		.9971	
	31.91	.467	160.2		752.2		.9931	
	31.78	.254	160.2		722.9		.9569	
RF	31.61	.027	160.2		000.0		0.0000	on foil

Date 2 Feb Test No. 23

Angle of Attack [illegible] flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 2

Lens distance from Window on foil

Initial Pointer Reading 31.40

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.18	11.720	158.3		751.0		1.0061	
	39.08	10.252	158.2		741.4		.9932	
RF	37.97	8.770	158.2		746.0		1.0000	
RF	37.00	7.475	158.1		746.3		1.0010	
RF	36.04	6.194	158.1		744.8		.9990	
RF	35.10	4.939	158.0		744.1		.9937	
RF	34.00	3.471	158.0		742.6		.9967	
RF	33.04	2.189	157.9		743.5		.9936	
RF	32.41	1.348	158.1		742.8		.9964	
	32.24	1.121	158.1		741.0		.9939	
RF	32.09	.921	157.9		745.0		1.0006	
	31.94	.721	157.9		744.0		.9992	
	31.78	.507	157.9		741.4		.9957	
RF	31.61	.280	157.9		727.6		.9772	[illegible]
	31.47	.093	157.7		633.[illegible]		.8483	[illegible]
	31.52	.160	157.9		687.0		.9254	

Date 2 Feb Test No. 24

Angle of Attack [illegible] Flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 1

Lens distance from Window on foil

Initial Pointer Reading 31.50

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.98	11.320	158.0		747.2		1.0029	
	39.08	10.119	158.2		750.4		1.0059	
RF	37.98	Beam hitting LE of	foil scattering	light &	[illegible]		–	
RF	37.01						A	See back
RF	36.02						B	
RF	34.96	4.617	160.5		743.7		.9826	
RF	33.99	3.324	157.2		737.1		.9319	
	32.99		159.2		557.3	–		Looks like [illegible]
	32.99	1.927	159.3		748.5		.9964	Good [illegible]
	32.50	1.335	159.3		752.9		1.0023	
[illegible]	32.33	1.108	159.4		753.1		1.0019	
	32.19	.921	[illegible]		754.9		1.0043	
	32.00	.667	159.4		760.5		1.0118	
[illegible]	31.86	.431	[illegible]		772 [illegible]		1.0268	[illegible]
	31.70	.267	159.6		784.0		1.0417	[illegible]
[illegible]	31.53	.040	159.7		803.1		1.0664	

Date 2 Feb Test No. 25

Angle of Attack -4.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station LE

Lens distance from Window on foil

Initial Pointer Reading 31.97

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	10.719	159.7		809.2		1.0762	
	39.00	9.384	159.7		811.6		1.0794	
	37.90	7.916	159.7		816.7		1.0862	
	36.95	6.648	159.8		815.3		1.0836	
CF	35.99	5.366	160.1		825.7		1.0954	
	34.88	3.885	159.1		824.4		1.1005	
	33.93	2.616	159.2		827.0		1.1026	
	33.72	2.416	159.3		827.2		1.1029	
RF	32.97	1.335	159.4		821.1		1.0941	
	32.81	1.121	159.4		817.8		1.0897	
	32.65	.908	159.4		813.4		1.0838	
	32.49	.694	159.4		804.0		1.0713	
RF	32.34	.494	159.5		793.4		1.0565	
	32.18	.280	[illegible]		774.[illegible]		1.0307	
	32.00	.040	[illegible]		744.2		.9910	
	32.11	.187	159.5		[illegible]		1.0213	

Date 2 Feb   Test No. 26

Angle of Attack -4.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station TE

Lens distance from Window on foil

Initial Pointer Reading 29.91

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.99	13.456	159.6		781.3		1.0397	
	39.00	12.134	159.6		779.8		1.0377	
	38.05	10.366	159.6		772.7		1.0363	
	36.94	9.234	159.6		771.4		1.0266	
	36.00	8.130	159.7		765.6		1.0182	
	34.89	6.648	159.7		749.8		.9972	
RF	33.92	5.353	159.7		757.7		1.0077	
	32.98	4.098	159.7		740.6		.9850	
RF	32.00	2.790	159.7		702.6		.9338	
RF	31.09	1.575						unable to track
RF	30.74	unable to	focus	because	when	beam	hit	
		edge of	foil	light	[illegible]	[illegible]	into	
		[illegible]	[illegible]					
	29.91							

Date 2 Feb Test No. 27

Angle of Attack -4.0 flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 9

Lens distance from Window on foil

Initial Pointer Reading 29.88

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.98	13.483	158.8		777.9		1.0404	
RF	39.00	12.174	159.1		773.5		1.0326	
RF	38.04	10.393	159.4		776.8		1.0350	
	36.94	9.424	159.4		773.1		1.0301	
	36.00	8.170	157.5		750.7		.9976	
RF	35.02	6.861	159.7		763.6		1.0155	
	33.92	5.373	159.8		746.7		.9924	
RF	32.98	4.138	159.9		744.1		.9884	
RF	32.01	2.343	160.0		694.4		.9218	
RF	30.90	1.262	160.2		556.0		.7371	
	30.75	1.161	160.3		522.2		.7051	
	30.60	.961	160.3		517.3		.6354	
RF	30.41	.708	160.3		269.6		.3572	Erratic RF Tracking
RF	30.29	.547	160.5		236.3		.3127	"
	30.10	.294	160.5		008.1		.0107	[illegible]

Date 3 Feb Test No. 28

Angle of Attack -4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 8

Lens distance from Window on foil

Initial Pointer Reading 30.12

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.01	13.202	158.4		764.1		1.0245	
RF	39.00	11.854	158.6		771.4		1.0330	
	38.04	10.572	158.7		768.2		1.0281	
	36.93	9.091	158.9		759.5		1.0152	
RF	36.00	7.849	159.6		749.3		.9971	
	35.02	6.541	157.6		764.7		1.0176	
	33.93	5.086	159.7		745.6		.9916	
RF	32.97	3.804	160.0		747.6		.9924	
	32.01	2.523	160.0		702.7		.9328	
RF	31.06	1.255	160.6		584.0		.7723	
	30.90	1.041	160.7		559.8		.7399	
	30.74	.823	161.0		553.0		.7282	
	[illegible]	.641	161.0		523.3		.6903	
	30.43	.414	161.1		503.9		.6643	
RF	30.29	.227	161.6		478.2		.6416	
	30.11	-.013	161.6		432.2		.5365	fluctuate badly sometimes touched at ≈ 0.0

Date 3 Feb Test No. 29

Angle of Attack -4.0 Side flat

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station 7

Lens distance from Window on foil

Initial Pointer Reading 30.12

	Pointer	Distance from Wall	~~Abscissa~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.99	13.176	158.4		779.5		1.0452	
	39.00	11.854	158.2		775.2		1.0401	
RF	38.04	10.572	158.1		772.4		1.0376	
	36.94	9.104	158.1		769.5		1.0337	
RF	36.00	7.849	158.0		753.9		1.0134	
	35.02	6.541	158.1		762.9		1.0249	
	34.09	5.300	158.1		745.4		1.0014	
RF	32.92	3.818	158.1		728.7		.9789	
	32.00	2.516	158.1		713.7		.9588	
RF	31.08	1.282	157.7		568.5		.7647	
	30.91	1.055	157.8		544.7		.7331	
	30.74	.823	157.8		527.1		.7095	
	30.59	.627	157.9		512.0		.6887	
	30.42	.400	157.9		495.7		.6668	
	31.31	1.529	158.0		605.2		.8135	
RF	31.68	2.032	157.7		672.3		.9043	
RF	30.27	.200	157.9		391.2		.5243	

30.10 on foil

Date 3 Feb   Test No. 30

Angle of Attack -4.0   Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 6

Lens distance from Window on foil

Initial Pointer Reading 31.21

	Pointer	Distance from Wall	~~[illegible]~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point
	40.01	11.747	158.5		735.2		1.0522
	39.00	10.379	158.4		733.4		1.0504
	38.05	9.131	158.4		733.2		1.0510
RF	36.94	7.649	158.2		730.9		1.0477
	35.99	6.381	158.3		776.5		1.0418
	35.03	5.099	158.3		750.9		1.0075
RF	34.09	3.845	158.3		767.8		1.0302
	32.99	2.376	158.3		742.1		.9957
RF	32.28	1.428	158.3		641.2		.8603
	32.71	2.002	158.1		715.2		.9658
	32.50	1.722	158.2		679.4		.9121
	32.00	1.055	158.1		578.8		.7776
	31.86	.868	158.1		556.8		.7430
	31.70	.654	158.2		519.6		.6976
	31.53	.427	158.1		492.7		.6619
	31.38	.227	158.2		[illegible]		.6211
	31.21	.000	[illegible]		406.7		.5460

Date 3 Feb Test No. 31

Angle of Attack -4.0 Side flat

Water Temp ____ Room Temp ____ Manomkter Tubes ____

Station 5

Lens distance from Window on foil

Initial Pointer Reading 31.16

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.00	11.801	158.9		795.5		1.0633	
39.00	10.466	158.2		795.9		1.0645	
38.04	9.134	158.9		797.1		1.0654	
36.94	7.716	158.7		796.5		1.0646	
36.00	6.461	158.1		795.1		1.0628	
35.02	5.153	158.2		794.1		1.0621	
33.93	3.698	159.0		781.4		1.0438	
32.98	2.430	158.9		751.0		1.0033	
RF 32.50	1.789	158.6		742.9		.9949	
32.10	1.255	158.6		646.0		.8651	
31.86	.934	158.7		554.0		.7414	
31.70	.721	158.6		518.0		.6737	
31.53	.494	158.6		431.2		.5776	
31.39	.307	158.6		433.6		.5374	
31.21	.067	158.6		355.0		.4754	
31.07							

Date 3 Feb Test No. 32

Angle of Attack -4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 4

Lens distance from Window on foil

Initial Pointer Reading 31.20

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	37.99	11.734	158.2		205.4		1.0772	
	39.00	10.412	158.2		208.4		1.0853	
	38.04	9.131	158.3		213.3		1.0912	
	36.93	7.649	158.3		206.1		1.0815	
	35.91	6.287	158.3		209.0		1.0854	
	35.03	5.113	158.5		726.6		.9737	
	34.55	4.472	158.6		569.3	looks Bad	.7624	
	34.24	4.052	158.6		372.4		.4987	
SF	35.77	6.101	158.7		223.7		1.1025	
	35.00	5.073	159.1		229.5		1.1073	
	34.09	3.858	159.2		229.5		1.1200	
	33.12	2.563	159.3		235.5		1.1133	
	32.65	1.936	159.3		210.1		1.0801	
	32.32	1.495	158.5		[illegible]		1.0132	
[illegible]	32.12	1.303	158.6		[illegible]		.9323	
	32.03	1.068	[illegible]		[illegible]		.7179	
	31.35	.862	[illegible]		[illegible]		.6624	

(CONT)

Date 3 Feb Test No. 32

Angle of Attack -4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 4

Lens distance from Window on foil

Initial Pointer Reading 31.20

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
31.70	.667	159.7		381.1		.5068	
31.53	.441	159.7		296.9		.3949	
31.40	.217	159.9		158.4		.2104	
31.22	.027	159.8		107.3		.1426	

Date 3 Feb Test No. 33

Angle of Attack -4.0 Side flat

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station 3

Lens distance from Window on foil

Initial Pointer Reading 31.46

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.02	11.427	158.0		204.7		1.0317	
	39.00	10.065	158.1		813.3		1.0726	
	38.04	3.784	158.1		218.3		1.0993	
RF	36.95	7.329	158.3		230.9		1.1148	
	36.00	6.060	158.2		821.5		1.1163	
RF	35.04	4.779	158.1		858.5		1.1533	
	34.09	3.511	158.0		877.7		1.1840	
RF	32.98	2.029	158.0		919.3		1.2358	
	32.50	1.338	158.2		903.4		1.2129	
	32.33	1.161	158.0		839.2		1.1281	
RF	32.19	.974	158.0		[illegible]		.8303	
	32.00	.721	[illegible]		[illegible]		.5097	
	31.77	.547	157.9		[illegible]		.2171	
	31.70	.320	[illegible]		43.0		.0578	
	31.5[illegible]							[illegible]

1 of 2

Date 3 Feb Test No. 34

Angle of Attack -4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 2

Lens distance from Window on foil

Initial Pointer Reading [illegible]

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.02	11.120	157.7		794.0		1.0828	
RF	[illegible].00	9.758	157.[illegible]		[illegible].1		1.0769	
	38.04	8.477	157.7		[illegible]		1.0948	
	36.94	7.008	157.6		820.9		1.1063	
RF	36.00	5.753	157.4		[illegible]		1.1248	
	35.02	4.445	157.6		[illegible]		1.1444	
RF	33.91	2.963	157.5		[illegible]		1.1337	
	33.00	1.749	157.5		852.6		1.1497	
	[illegible].64	1.263	157.6		[illegible]	Not Sure Might have been on	Manual	1.1039
	[illegible]	.841	157.7		822.4		1.1076	
RF	[illegible]	.654	157.8		553.3		.7448	
	[illegible]	.801	[illegible]		[illegible]		1.2005	
	[illegible]	1.215	157.7		[illegible]		1.2173	
	[illegible]	1.615	157.6		[illegible]		1.2339	
	[illegible]	2.833	157.6		[illegible]		1.1977	
	[illegible]	.654	[illegible]		521.5		.7046	
	[illegible]	.314	[illegible]		[illegible]		1.1323	

Date 3 Feb Test No. 34

Angle of Attack -4.0 Side Flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 2

Lens distance from Window on foil

Initial Pointer Reading 31. [illegible]

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
32.00	.414	157.2 157.2		131.0		.1770	
31.85	.214	157.3		-84.9		-.1146	
RF 31.70					on FOIL		

Date [illegible] Feb. Test No. 35

Angle of Attack -4.0 Side ______

Water Temp ____ Room Temp ____ Manometer Tubes FLAT

Station 1

Lens distance from Window on foil

Initial Pointer Reading 31.82

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point
	39.98	10.293	[illegible]		[illegible]		1.0755
	[illegible]	9.525	[illegible]		[illegible]		1.0762
RF	37.0[illegible]	Light	scatter of	LE into	eyepiece	see back	(A)
	36.98		[illegible]		[illegible]		
	36.00		[illegible]		[illegible]	Manual	track (mistake)
	[illegible]		[illegible]		[illegible]		
	[illegible]		[illegible]		[illegible]		
	[illegible]		[illegible]		[illegible]		
	35.91		[illegible]		[illegible]		
	[illegible]	6.225	[illegible]		[illegible]		1.0951
RF	[illegible]	5.530	153.2		821.4		1.1028
[illegible]	35.02	4.225	155.1		2247		1.1077
	34.50	[illegible]	[illegible]		[illegible]		1.0727
	34.10	[illegible]	[illegible]		[illegible]		1.1234
RF	[illegible]	2.176	[illegible]		[illegible]		1.1338
	[illegible]	[illegible]	[illegible]		[illegible]		1.1576
	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]

Date 3F.1 Test No. 35

Angle of Attack -4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 1

Lens distance from Window on foil

Initial Pointer Reading 31.82

	Pointer	Distance from Wall	RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
RF	32.[illegible]	1.103	157.7		7[illegible]4.8		1.1702	
recure	32.50	.903	157.[illegible]		8[illegible] 4		1.1857	
RF	32.32	.667	157.7		905.1		1.2113	
	32.19	.494	157.7		913.7		1.2230	
2 1/2 hr later	32.11	.387	152.8		912.1	reproduce		1.2199
	32.08	.347	157.8		891.7		1.1926	
PF	32.00	.240	159.0		[illegible] 4	could not track well	erratic readings	
	31.84	.027					.5536	on foil

Date 6 Feb　　　Test No. 36

Angle of Attack +4.0　Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station LE

Lens distance from Window on foil

Initial Pointer Reading 31.00

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	12.014	159.4		716.3		.9562	
	39.00	10.679	159.3		712.6		.9518	
	38.04	9.393	159.7		708.9		.9445	
	37.01	8.023	159.7		703.0		.9366	
	35.99	6.661	159.8		696.3		.9271	
	35.02	5.366	159.8		690.9		.9199	
	34.09	4.125	159.9		691.1		.9196	
	32.98	2.643	159.9		671.6		.8937	
PF	31.97	1.295	160.3		573.1		.7859	
RF	31.53	.708	160.4		556.4		.7321	
·F	31.07	unable	to focus:	Bright	spot in	focus pattern		
	30.90	Same	again					
		light	scattering	on LE	and directed	to	eye piece	

Date ~~6 Feb~~ 6 Feb   Test No. 37

Angle of Attack +4.0   Side flat

Water Temp ____   Room Temp ____   Manometer Tubes ____

Station TE

Lens distance from Window on foil

Initial Pointer Reading 32.93

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.97	9.393	157.4		735.8		.9947	
	39.00	8.103	157.4		735.3		.9940	
	38.05	6.735	157.4		735.0		.9936	
	36.74	5.353	157.3		729.2		.9264	
PF	36.00	4.073	157.1		727.6		.9255	
	35.02	2.777	157.1		722.3		.9783	
	34.10	1.562	157.1		741.0		1.0036	
RF	33.76	1.108	157.1		770.0		1.0429	
	33.61	.908	157.0		770.7		1.0445	
R=	33.45	.694	156.9		737.1		.9996	
	33.29	.481	157.0		744.3		1.0087	
	33.13	.267	156.3		753.6		1.0294	
	32.98	.067						on TE

Date 6 Feb Test No. 38

Angle of Attack +4.0 Side flat

Water Temp ____ Room Temp ____ Manometter Tubes ____

Station 9

Lens distance from Window on foil

Initial Pointer Reading 33.09

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
34.12	1.375	157.4		736.7		.9959	
33.67	.774	157.7		738.6		.9966	
33.60	.621	157.5		726.2		.9811	
33.44	.467	157.5		739.8		.9994	
33.29	.267	157.6		730.4		.9861	
33.12	.040	157.6		722.1		.9749	
34.99	2.536	157.7		720.5		.9756	
36.00	3.235	157.6		710.4		.9591	
36.90	5.036	157.8		732.8		.9331	
38.00	6.554	157.[illegible]		732.6		.9378	
38.95	7.323	157.8		737.1		.9939	
40.04	9.278	157.7		[illegible]		.9[illegible]	
35.97	3.371	157.[illegible]		735.[illegible]		.9716	

Date 6 Feb   Test No. 39

Angle of Attack +4.0   Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 8

Lens distance from Window on foil

Initial Pointer Reading 32.79

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.98	9.598	157.6		729.9		.9854	
	38.85	8.070	157.6		731.5		.9876	
RF	37.90	6.821	157.8		721.8		.9733	
	36.94	5.540	157.8		732.2		.9873	
RF	36.00	4.285	157.7		732.0		.9877	
RF	35.02	2.977	157.7		733.0		.9890	
RF	34.09	1.735	157.9		733.9		.9890	
	33.70	1.215	157.7		733.5		.9897	
	33.60	1.081	157.7		735.2		.9920	
	33.45	.881	157.6		732.2		.9886	
	33.30	.681	157.6		726.6		.9810	
RF	33.12	.441	157.7		730.6		.9853	
RF	33.00	.280	157.5		700.4		.9462	
	32.50							on foil

Date ~~14 Feb~~ 14 Feb Test No. 40

Angle of Attack +4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 7

Lens distance from Window on foil

Initial Pointer Reading 32.50

Readjusted laser (Not real good data)

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	10.012	157.9		716.0		.9648	
RF	38.93	8.533	158.0		719.1		.9684	
RF	38.04	7.395	157.2		716.7		.9664	
RF	36.94	5.927	157.2		717.7		.9677	
	36.00	4.672	157.9		713.2		.9611	
RF	33.76	1.602	156.5		716.9		.9747	
	34.33	2.443	156.6		713.7		.9697	
	33.29	1.055	156.6		713.8		.9699	
RF	33.12	.828	156.6		723.3		.9828	
	32.99	.654	156.6		721.6	Weak trace	.9895 erratic but reproduced	
	32.80	.400	156.6		710.7	when	retraced .9657	
	32.64	.187	156.7		[illegible]		.9516	
	32.50							on foil

Date 14 Feb Test No. 41

Angle of Attack +4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 6

Lens distance from Window on foil

Initial Pointer Reading 32.20

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.01	10.426	156.9		713.4		.9675	
	39.00	9.077	156.9		717.5		.9730	
	38.05	7.309	157.0		720.5		.9765	
RF	37.10	6.541	156.9		720.6		.9772	best signal of day yet
	35.99	5.059	156.9		717.2		.9726	
	35.01	3.751	157.0		718.3		.9735	
RF	33.92	2.296	156.9		711.4		.9648	
RF	33.21	1.348	156.8		709.5		.9628	
	33.12	1.228	156.8		713.3		.9679	
	32.98	1.041	156.7		710.9		.9653	
	32.80	.801	156.2		707.5	erratic but	.9601	held
	32.65	.601	156.8		708.7	track	.9617	
	32.50	.400	156.9		707.2		.9599	
	32.32	.174	[illegible]		[illegible]		.9511	
	32.20							on foil

Date 14 Feb Test No. 42

Angle of Attack +4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 5

Lens distance from Window on foil

Initial Pointer Reading 32.14

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
39.97	10.452	156.6		713.5		.9695	
39.00	9.157	156.6		711.1		.9662	
38.04	7.876	156.6		713.2		.9690	
36.93	6.394	156.6		711.5		.9667	
36.16	5.366	156.6		706.4		.9598	
35.02	3.345	156.6		705.2		.9582	
33.92	2.376	156.6		698.5		.9491	
33.12	1.308	156.5		699.4		.9509	
32.99	1.135	156.7		700.8		.9516	
32.80	.831	156.6		696.6		.9465	
32.65	.631	156.6		695.7		.9453	
32.50	.431	156.7		695.0		.9437	
32.33	.254	[illegible]		677.[illegible]		.9230	
32.19	.067	[illegible]		517.9		.7064	

Date 14 Feb Test No. 43

Angle of Attack +4.0 Side flat

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station 4

Lens distance from Window on foil

Initial Pointer Reading 32.01

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	10.666	156.9		705.4		.9566	
RF	39.00	9.331	157.0		704.4		.9547	
	37.90	7.863	157.0		703.2		.9530	
	36.95	6.594	156.9		696.6		.9447	
	36.00	5.326	157.1		694.4		.9405	
	35.01	4.005	157.1		690.5		.9352	
RF	34.09	2.777	157.3		681.0		.9212	Erratic
RF	32.98	1.295	156.7		695.7		.9447	
RF	32.80	1.055	156.3		679.5		.9250	
	32.64	.341	156.3		702.4		.9644	
RF	32.50	.654	157.0		541.7		.7342 →	Manual
	32.33	.427						

Date 15 Feb Test No. 44

Angle of Attack +40 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 3

Lens distance from Window on foil

Initial Pointer Reading 31.38

Good data (started [illegible])

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.01	11.520	156.6		703.1		.9621	
39.00	10.172	156.9		690.5		.9364	
38.04	8.390	157.0		701.3		.9505	
NF 36.92	7.395	156.3		693.5		.9441	
36.00	6.167	156.5		687.8		.9351	
35.02	4.359	156.4		681.6		.9273	
34.10	3.631	156.4		674.1		.9171	
32.97	2.149	156.7		663.4		.9076	
32.80	1.896	156.6		667.0		.9063	
32.64	1.682	156.6		665.7		.9045	
32.50	1.495	156.7		663.0		.9003	
32.32	1.255	156.2		663.9		.9007	
32.18	1.062	156.7		663.0		.9003	
FF 32.00	.828	156.6		662.4		.9000	
31.85	.627	156.[illegible]		663.3		.9001	
31.70	.427	15[illegible]		661.9		.[illegible]	
31.53	.200	156.		651.3		.8838	

31.38

on foil

Date 15 Feb Test No. 45

Angle of Attack +4.0 Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 2

Lens distance from Window on foil

Initial Pointer Reading 31.12

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.96	11.801	156.7		709.4		.9633	
	39.00	10.519	156.6		705.4		.9525	
RF	38.05	9.251	156.8		702.1		.9527	
RF	36.94	7.769	156.8		694.9		.9430	
RF	36.00	6.514	156.8		686.7		.9321	
RF	35.02	5.206	156.9		677.3		.9185	
	34.09	3.965	156.9		667.8		.9056	
	32.97	2.470	157.0		649.1		.8797	
	32.00	1.175	157.0		630.0		.8538	
	31.88	1.015	157.0		627.4		.8503	
	31.70	.774	157.0		622.8		.8441	
	31.51	.521	157.3		623.7		.8437	
	31.39	.360	157.2		620.7		.8404	
	31.21	.120	157.0		605.8		.8210	
	31.10	-.027						on foil

Date ~~15 Feb~~ 15 Feb   Test No. 46

Angle of Attack +4.0   Side flat

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 1

Lens distance from Window on foil

Initial Pointer Reading 31.04

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point
	39.97	11.921	157.3		713.1		.9646
	39.00	10.626	157.3		708.8		.9583
	38.04	9.344	157.4		704.8		.9522
RF	36.93	7.863	157.4		677.2		.9452
	36.00	6.621	157.5		693.2		.9365
	35.01	5.300	157.4		683.2		.9236
	34.09	4.071	157.3		671.0		.9077
	33.12	2.777	157.3		649.4		.8784
RF	32.12	1.522	157.2		609.8		.8254
	32.00	1.282	157.2		601.1		.8136
	31.86	1.095	157.0		589.6		.7791
	31.70	.881	157.1		578.3		.7733
	31.52	.654	157.2		557.1		.7563
	31.37	.441	157.1		541.7		.7340
	31.21	.227	157.0		527.4		.7175
	31.05	.013	157.0		516.2		.6776
RF	32.57	2.042	157.0		627.7		.8507

Date 15 Feb Test No. 47

Angle of Attack +4.0 Side Flat

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station 4 (repeat)

Lens distance from Window on foil

Initial Pointer Reading 31.52

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.00	11.320	156.1		708.3		.9655	
39.00	9.985	155.9		704.6		.9617	
38.05	8.717	157.3		709.2		.9593	
36.93	7.222	157.3		705.1		.9544	
36.00	5.920	157.3		700.8		.9428	
RF 35.02	4.672	157.6		699.8		.9448	
34.09	3.431	157.8		697.7		.9408	
33.29	2.363	157.9		694.0		.9352	
32.32	1.062	158.2		692.6		.9315	
32.18	.881	158.1		691.9		.9312	
32.00	.641	158.3		692.1		.9303	
31.86	.454	158.2		691.0		.9222	
31.70	.240	157.6		684.7		.9186	
31.53	.013	153.6		[illegible]		.7863	

Date 16 Feb Test No. 48

Angle of Attack +4.0 Side convex

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station LE (Just ahead of foil)

Lens distance from Window on foil

Initial Pointer Reading 30.59

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point
	40.01	12.575	156.8		828.6		1.1244
	39.00	11.227	157.2		830.3		1.1233
	38.04	9.945	157.2		830.0		1.1234
	36.93	8.463	157.1		830.4		1.1247
P.F.	36.00	7.222	157.4		828.9		1.1205
	35.01	5.900	157.7		827.2		1.1161
	34.09	4.672	157.6		820.3		1.1075
	32.96	3.164	157.5		808.0		1.0916
	32.00	1.882	157.5		791.4		1.0692
	31.85	1.632	157.5		787.7		1.0642
	31.70	1.482	157.6		784.3		1.0589
	31.52	1.241	157.6		778.1		1.0505
	31.32	1.055	157.5		770.3		1.0407
	31.20	.814	157.6		760.6		1.0269
	31.05	.614	157.7		747.1		1.0107
	30.90	.414	157.7		724.8		.9773
	30.73	.137	157.8		606.8		.71[illegible]

Date 16 Feb Test No. 48

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station LE (Just ahead)

Lens distance from Window on foil

Initial Pointer Reading 30.59

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
30.58	-.013	157.9		479.5		.6461	
30.41	-.240	157.8		526.2		.7095	
30.26	-.441	157.9		564.2		.7603	

Date 16 Feb Test No. 49

Angle of Attack +4.0 Side Convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station TE (Just aft)

Lens distance from Window on foil

Initial Pointer Reading 29.20

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.98	14.390	157.6		828.6		1.1187	
	39.00	13.032	157.5		827.4		1.1178	
	38.03	11.787	157.6		827.2		1.1168	
	36.93	10.319	157.6		824.1		1.1126	
RF	36.00	9.077	157.7		818.8		1.1048	
	35.01	7.756	158.0		814.3		1.0966	
	34.08	6.514	158.0		804.4		1.0333	
	32.98	5.046	157.9		790.9		1.0658	
	32.00	3.738	157.9		777.3		1.0474	
	31.05	2.470	157.9		757.7		1.0210	
	30.59	1.856	157.8		743.0		1.0036	
	30.10	1.201	157.0		724.3		.[illegible]	
RF	[illegible]		[illegible]		[illegible]		[illegible]	Freq Shutter
[illegible]	[illegible]		156.0		[illegible]		[illegible]	[illegible]
RF	29.93	.974	156.7		626.1		.8502	
[illegible]	[illegible]	.801	15[illegible].3		463[illegible]		.6291	[illegible]
	29.63	.574	157.0		279.3		.3785	

Date 13 Feb Test No. 49A

Angle of Attack +4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station TE

Lens distance from Window on Foil

Initial Pointer Reading 30.50

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
31.56	1.415	158.7		009.1		.0122	
Would also track at ≈ 1 volt but this appeared to be freq shifter signal. At any rate the signal was so weak would not display only amplified output, and that may have been a false signal							
31.35	but	couldn't	get	any signal	other	than	1 volt
freq	shifts						

Date 17 Feb Test No. 50

Angle of Attack +4.0 Side CONVEX

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 5

Lens distance from Window on foil

Initial Pointer Reading 32.28

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.98	10.279	158.0		883.5		1.1898	
	39.00	8.971	156.2		883.6		1.2037	
	38.04	7.629	156.5		896.9		1.2194	
	37.10	6.434	156.4		906.6		1.2334	
	36.30	5.366	156.4		920.0		1.2516	
	35.35	4.098	156.5		936.5		1.2733	
RF	34.40	2.830	156.6		960.6		1.3052	
	33.44	1.548	156.7		976.0		1.3339	
	33.30	1.362	156.9		990.1		1.3427	
	33.12	1.121	156.9		995.4		1.3499	
	32.97	.921	156.9		999.7		1.3557	
	32.80	.694	157.0		1000.2		1.3555	
RF	32.64	.481	[illegible]		[illegible]		1.3545	A weak signal
	32.64	.481	157.2		[illegible]		1.3550	Strange readings
	32.50	.294	157.2		912.7		1.2354	[illegible]
	32.31	.040						on foil

Date 17 Feb Test No. 51

Angle of Attack +4.0 Side CONVEX

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 4

Lens distance from Window on foil

Initial Pointer Reading 32.51

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
39.97	9.958	158.7		[illegible]		1.1861	
39.00	8.664	158.9		896.1		1.1999	
32.04	7.382	158.6		973.6		1.3129	
37.10	6.127	158.9		984.5		1.3183	
36.13	4.832	158.7		987.2		1.3236	
35.20	3.591	158.6		[illegible]		1.3272	
34.22	2.283	158.7		974.0		1.3327	
33.45	1.255	158.7		997.9		1.3379	
33.29	1.041	158.6		999.9		1.3415	
33.11	.801	158.6		1000.7		1.3425	
32.98	.627	158.7		1000.5		1.3414	
32.80	.327	158.8		1000.2		1.3402	
32.65	.137	158.8		999.7		1.3395	
[illegible]	−.013	[illegible]		[illegible]		1.3334	

from 32.74 on [illegible] signal which looked good data [illegible] to 1mm [illegible] signal and [illegible]

1 of 2

Date 17 Feb   Test No. 52

Angle of Attack +4.0   Side Convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 6

Lens distance from Window on foil

Initial Pointer Reading 32.40

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	10.145	158.3		877.9		1.1827	
	39.00	8.810	158.5		886.4		1.1899	
	38.04	7.529	158.6		891.3		1.1958	
	37.10	6.274	158.6		905.6		1.2150	
	36.13	4.979	158.5		938.6		1.2600	
	35.20	3.738	158.6		997.1		1.3404	?
RF	34.55	2.870	158.7		999.8		1.3405	<
	33.60	1.602	158.7		961.4		1.2890	
	34.01	2.149	158.6		946.8		1.2702	
	34.50	2.803	157.2		929.2	flow not up	1.2577	verified & checked
	35.45	4.071	158.9		924.2	to speed	1.2376	signal
	36.40	5.340	158.7		940.9		1.2615	
	33.45	1.402	158.5		95[illegible].1		1.2866	
	34.35	2.603	158.6		94[illegible].7		1.2620	
	33.29	1.188	158.6		966.6		1.2968	
	33.11	.948	158.6		976.7		1.3106	
	32.76	.748	158.5		985.2		1.3226	

Date 17 Feb Test No. 52

Angle of Attack +4.0 Side CONVEX

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 6

Lens distance from Window on foil

Initial Pointer Reading 32.40

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
32.80	.534	153.5		989.5		1.3283	
Raw signal becomes dominated by freq shifter signal but continues to track well when signal set into tracker. I don't trust results after and including here. Perhaps so much turbulence signal too weak but [illegible] signal much [illegible] real [illegible]							
32.64	.320	153.6		996.3		1.3366	
32.50	.133	152.5		992.1		1.3299	
32.33	−.107	153.5		1000.4		1.3430	
[illegible] on foil but still tracks about 1000 volts							
RF 32.55	.200	152.0		956.7		1.2[illegible]34	True signal
32.70	.400	157.6		964.0		1.3015	[illegible]!
32.40	[illegible] shifter						
32.80	.534	155.6		968.1		1.29[illegible]8	
32.90	.667	155.6		965.2		1.2949	
32.97	.921	155.6		962.6		1.2914	Checked [illegible] Vel = 0

Date 18 Feb Test No. 53

Angle of Attack +4.0 Side CONVEX

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 7

Lens distance from Window on foil

Initial Pointer Reading 31.80

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	10.946	157.9		849.1		1.1442	
RF	39.00	9.611	157.5		851.0		1.1497	
RF	38.04	8.330	157.5		853.0		1.1524	
RF	37.10	7.075	157.4		856.4		1.1577	
RF	35.99	5.593	157.3		857.8		1.1603	
	35.01	4.285	157.3		859.5		1.1626	
RF	34.08	3.044	157.3		861.6		1.1655	
RF	33.11	1.749	157.5		863.6		1.1667	
	32.42	.828	157.5		865.3		1.1690	
	32.28	.641	158.0		868.3		1.1700	
	32.17	.494	158.1		869.7		1.1707	
RF	32.00	.267	158.4		[illegible]		1.1230	
RF	31.85	.067	158.7		603.3		.8029	Weak Signal
RF	31.70							in foil

Date ~~13 Feb~~ Test No. 54

Angle of Attack +4.0 Side CONVEX

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 2

Lens distance from Window on foil

Initial Pointer Reading 31.30

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	11.614	159.3		846.1		1.1301	
	39.00	10.279	159.2		846.6		1.1315	
	38.04	8.997	159.2		842.1		1.1335	
RF	37.10	7.742	159.3		844.9		1.1235	
	35.99	6.261	159.4		843.5		1.1260	
RF	35.00	4.939	159.3		838.4		1.1199	
	34.09	3.724	159.3		830.3		1.1090	
	33.11	2.416	159.4		820.4		1.0951	
RF	32.18	1.175	159.6		804.9		1.0731	
	32.60	1.735	159.6		815.0		1.0366	
	31.95	.868	159.6		793.7		1.0648	
RF	31.34	.721	159.7		796.2		1.0616	
	31.70	.534	159.6		[illegible]		[illegible]	
RF	31.52	.294	159.8		712.0		[illegible]	
	31.33	.107	159.9		465.5		.6194	[illegible] signal
	31.22							in foil

Date 18 Feb   Test No. ~~[illegible]~~ 55

Angle of Attack +4.0   Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 9

Lens distance from Window on foil

Initial Pointer Reading ~~[illegible]~~ 30.84

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	32.31	1.962	160.2		778.7		1.0345	
RF	33.39	3.404	160.0		800.6		1.0647	
	34.65	5.026	159.9		817.2		1.0374	
	36.09	7.008	160.0		831.9		1.1063	
RF	37.20	8.470	160.2		839.8		1.1154	
	38.30	9.958	160.1		843.2		1.1208	
	39.00	10.893	160.1		842.0		1.1190	
	39.90	12.094	160.1		844.7		1.1226	
RF	31.70	1.148	160.0		761.7		1.0130	
RF	31.52	.908	160.0		758.1	.	1.0032	
	31.39	.734	160.2		743.3		.9373	
	31.21	.494	160.3		695.7		.8307	
[illegible]	31.06	.294					[illegible]	[illegible]
	30.90	.080	160.1		265.7	.3521	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	

Date 12 Feb   Test No. 56

Angle of Attack +4.0   Side Convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 3

Lens distance from Window on foil

Initial Pointer Reading 32.19   32.18

Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.00	10.439	158.0		260.2		1.1584	
39.00	9.104	158.0		267.1		1.1677	
38.04	7.823	158.0		272.0		1.1743	
39.94	10.359	157.9		280.1		1.1260	
RF 35.99	5.036	158.0		292.1		1.2014	
35.02	3.791	158.3		303.4		1.2143	
34.09	2.550	158.4		317.3		1.2349	
33.11	1.241	158.6		337.6		1.2579	
32.96	1.041	158.6		341.3		1.2628	
32.80	.828	152.9		345.5		1.2661	
32.64	.614	158.7		349.9		1.2736	
32.49	.414	157.7		355.9		1.2816	
32.31	.174	158.0		[illegible]		1.2834	
32.18	.000	158.7		361.0		1.2868	
32.00							IN Foil

Date 18 Feb Test No. 57

Angle of Attack +4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 2

Lens distance from Window on foil

Initial Pointer Reading 31.50

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.01	11.360	158.8		853.–		1.1437	
	39.00	10.012	158.9		855.5		1.1456	
	38.03	8.717	158.9		857.0		1.1503	
	36.92	7.235	159.0		863.1		1.1550	
	35.80	5.740	158.7		867.0		1.1610	
RF	34.70	4.272	159.1		873.0		1.1675	
	33.60	2.803	159.2		877.8		1.1734	
	32.50	1.335	159.2		887.7		1.1864	
	32.31	1.081	159.1		889.7		1.1899	
	32.18	.908	159.2		891.8		1.1919	
	32.01	.681	159.2		894.9		1.1961	
	31.85	.467	159.3		896.4		1.1973	
	31.70	.267	159.4		901.0		1.2027	
	31.51	.013	159.4		900.2		1.2016	
	31.37							IN foil

Date 18 Feb Test No. 53

Angle of Attack +4.7 Side CONVEX

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 1

Lens distance from Window on foil

Initial Pointer Reading 31.16

	Pointer	Distance from ~~Wall~~ Foil	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.92	11.774	159.6		248.0		1.1305	
	39.00	10.466	159.8		249.4		1.1310	
RF	38.03	9.171	159.5		247.0		1.1326	
	36.92	7.689	159.6		250.1		1.1333	
	36.00	6.461	159.6		248.4		1.1311	
	34.97	5.036	159.6		246.2		1.1281	
	34.02	3.378	159.5		242.5		1.1239	
NF	33.11	2.603	157.6		237.7		1.1168	
	32.17	1.348	159.5		233.6		1.1120	
	32.00	1.121	159.5		233.3		1.1116	
	31.84	.902	159.6		232.0		1.1092	
	31.70	.721	159.7		234.9		1.1124	
	31.52	.451	157.7		236.5		1.1145	
	31.38	.274	157.7		[illegible]		1.1156	
	31.20	.053	159.7		242.4		1.1224	
	31.04							IN foil

Date 13 Feb Test No. 59

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station TE

Lens distance from Window on foil

Initial Pointer Reading 31.76

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.92	10.993	157.1		307.6		1.0918	
	37.00	9.665	157.1		307.5		1.0917	
	38.04	8.333	157.1		306.7		1.0906	
	37.10	7.128	157.0		305.5		1.0897	
	36.00	5.660	157.0		302.4		1.0855	
	35.02	4.322	157.3		797.0		1.0761	
	34.09	3.110	157.3		736.2		1.0616	
RF	33.12	1.915	157.5		767.4		1.0376	
	32.50	.933	157.6		749.9		1.0093	
	32.32	.748	157.6		727.4		.9938	
	32.17	.547	157.8		732.0		.9352	
	32.00	.333	157.7		715.6		.9638	
	31.86	.133	157.3		[illegible]		.8422	
	31.70	[illegible]	[illegible]		[illegible]	IN		Very weak Erratic signal
	31.51	[illegible]	[illegible]		[illegible]	Foil		"

Date 19 Feb Test No. 60

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 9

Lens distance from Window on foil

Initial Pointer Reading 32.00

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.00	10.679	158.4		210.6		1.0869	
39.00	9.344	158.6		214.1		1.0902	
38.04	8.063	158.8		215.3		1.0904	
37.10	6.302	159.0		216.2		1.0903	
35.98	5.313	159.4		816.6		1.0801	
35.00	4.005	157.8		803.5		1.0815	
34.08	2.777	157.3		793.1		1.0742	
33.11	1.482	158.0		724.5		1.0546	
32.63	.241	158.2		777.3		1.0436	
32.50	.167	158.3		776.6		1.0420	
32.22	[illegible]						
32.17	[illegible]			at all			
32.00	[illegible]		more at				on foil
32.25	[illegible]						

Date 17 Feb Test No. 61

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 3

Lens distance from Window on foil

Initial Pointer Reading 32.40

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.98	10.119	158.7		222.7		1.1010	
	39.00	8.310	158.7		224.3		1.1032	
	38.04	7.529	158.7		227.3		1.1072	
	37.10	6.274	158.7		231.0		1.1121	
	35.99	4.792	158.6		233.0		1.1155	
	35.01	3.434	158.8		236.3		1.1185	
	34.08	2.243	158.6		233.7		1.1232	
RF	33.43	1.375	157.7		240.6		1.1250	
	33.29	1.188	158.5		241.4		1.1275	
	33.11	.948	158.5		249.1		1.1378	
	32.96	.748	158.7		245.4		1.1314	
	32.80	.534	158.6		253.5		1.1430	
	32.64	.320	158.7		[illegible]		1.1322	
	32.50	.133	158.7		[illegible]		1.1948	[illegible]
	32.32							in foil

Date 20 Feb Test No. 62

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 7

Lens distance from Window on foil

Initial Pointer Reading 32.49

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
39.98	9.998	158.6		827.1		1.1076	
39.00	8.690	158.9		832.6		1.1129	
38.02	7.332	159.1		839.7		1.1210	
37.09	6.141	158.2		845.3		1.1306	
35.79	4.672	159.2		858.3		1.1451	
35.01	3.364	159.0		873.1		1.1663	
34.07	2.109	158.4		891.7		1.1956	
RF 33.11	.828	158.7		902.6		1.2072	
32.76	.627	159.0		905.6		1.2097	
32.80	.414	157.3		911.7		1.2155	
32.63	.187	159.1		912.3		1.2179	
32.50							on foil

Date 20 Feb Test No. 63

Angle of Attack -4.0 Side Convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 6

Lens distance from Window on foil

Initial Pointer Reading 32.49

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
39.99	10.012	158.4		831.8		1.1153	
39.00	8.690	158.6		840.0		1.1249	
38.03	7.395	158.8		847.9		1.1340	
37.09	6.141	158.9		859.3		1.1486	
35.99	4.672	158.4		870.7		1.1675	
35.01	3.364	158.2		890.7		1.1958	
34.08	2.123	158.2		914.8		1.2282	
2F 33.11	.828	158.2		932.3		1.2523	
33.52	1.375	158.2		920.8		1.2362	
32.96	.627	158.2		936.7		1.2576	
32.80	.414	158.1		943.2		1.2671	
32.64	.200	158.1		947.9		1.2734	
32.50	.013	158.1		938.3		1.2605	
32.34							in foil

Date 20 Feb Test No. 64

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 5

Lens distance from Window on foil

Initial Pointer Reading 32.76

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.00	7.665	158.2		829.5		1.1136	
39.00	7.330	158.3		836.8		1.1227	
38.02	7.022	158.2		843.4		1.1323	
37.10	5.793	158.1		853.2		1.1462	
35.98	4.298	157.2		870.2		1.1683	
34.87	2.817	158.1		884.1		1.1877	
33.75	1.322	158.1		911.0		1.2238	
33.60	1.121	158.1		913.7		1.2275	
33.42	.831	158.1		918.0		1.2332	
33.29	.708	158.0		922.2		1.2397	
33.11	.467	157.9		925.7		1.2454	
32.97	.330	158.2		933.3		1.2522	
32.80							on foil

Date 20 Feb Test No. 65

Angle of Attack -4.0 Side Convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 4

Lens distance from Window on foil

Initial Pointer Reading 32.25

	Pointer	Distance from wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	39.99	10.232	158.5		814.1		1.0909	
	39.00	9.011	158.7		820.6		1.0782	
	38.03	7.716	158.6		822.9		1.1020	
	36.92	6.234	158.6		829.0		1.1102	
	35.80	4.739	158.6		839.5		1.1242	
RF	34.70	3.271	158.7		845.4		1.1314	
	33.60	1.802	158.6		857.7		1.1486	
	33.42	1.562	158.7		861.6		1.1531	
	33.29	1.378	158.6		861.0		1.1530	
	33.11	1.148	158.6		864.2		1.1573	
	32.96	.948	158.6		866.1		1.1599	
	32.80	.734	158.6		869.6		1.1645	
	32.65	.534	158.6		872.1		1.1677	
	32.49	.320	158.7		876.7		1.1732	
	32.32	.073	158.7		872.0		1.1770	
	32.16							IN foil

Date 20 Feb Test No. 66

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 3

Lens distance from Window on foil

Initial Pointer Reading 31.51

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	11.333	158.7		794.1		1.0623	
	39.00	9.998	158.7		793.1		1.0614	
	38.02	8.690	158.6		791.1		1.0594	
	36.92	7.222	158.6		787.6		1.0547	
	35.81	5.740	158.5		785.4		1.0524	
	34.70	4.258	158.7		779.4		1.0431	
	33.60	2.790	158.5		773.3		1.0362	
RF	32.49	1.302	152.7		764.7		1.0234	
	32.31	1.068	158.7		764.9		1.0237	
	32.17	.881	158.7		763.3		1.0215	
	32.00	.654	158.7		761.6		1.0193	
	31.84	.441	158.6		761.0		1.0191	
	31.69	.240	158.8		760.9		1.0177	
	31.52	.013	158.8		757.3		1.0129	
	31.20							IN foil

Date 20 Feb Test No. 67

Angle of Attack -4.0 Side Convex

Water Temp ______ Room Temp ______ Manometer Tubes ______

Station 2

Lens distance from Window on foil

Initial Pointer Reading 31.02

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
39.93	11.961	158.4		779.1		1.0447	
39.00	10.653	158.4		778.1		1.0433	
37.89	9.171	158.4		771.3		1.0342	
36.91	7.863	158.4		764.0		1.0244	
35.90	6.514	158.5		755.3		1.0121	
35.01	5.326	158.6		744.9		.9975	
34.06	4.058	158.6		727.3		.9740	
33.11	2.790	158.6		704.1		.9429	
32.00	1.308	158.7		665.3		.8904	
31.85	1.108	158.8		661.7		.8850	
31.70	.908	158.6		653.7		.8754	
31.51	.654	158.6		642.7		.8627	
31.39	.494	158.5		641.7		.8599	
31.20	.240	158.6		633.0		.8477	
31.04	.027	158.6		625.5		.8316	
30.80	-.274						IN foil

Date 20 Feb   Test No. 68

Angle of Attack -4.0   Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 1

Lens distance from Window on foil

Initial Pointer Reading 30.30

	Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
	40.00	13.349	158.2		771.2		1.0315	
RF	39.00	12.014	158.4		764.3		1.0243	
RF	38.02	10.706	156.9		753.6		1.0201	
	37.10	9.478	159.4		758.1		1.0101	
	36.00	8.009	153.7		741.3		.9928	
	35.01	6.658	159.0		728.6		.9733	
RF	34.08	5.446	153.7		702.9		.9474	
	33.11	4.152	159.1		681.9		.9103	
	32.13	2.843	158.8		636.2		.8507	
	32.00	2.670	153.7		630.8		.8442	
	31.85	2.470	159.0		621.1		.8297	
RF	31.16	1.543	153.2		554.1		.7439	
	31.56	2.032	153.5		592.4		.7938	
	31.05	1.402	[illegible]		542.5		.7283	
	30.90	1.201	158.5		521.3		.6985	
	30.73	.974	[illegible]		497.3		.6660	
RF	[illegible]	[illegible]	[illegible]		467.7		.6286	

Date 20 Feb Test No. 63

Angle of Attack -4.0 Side Convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station 1

Lens distance from Window on foil

Initial Pointer Reading 30.30

	Pointer	Distance from Wall	Manometer RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
RF	30.41	Can not get signal. Pattern looks OK, not very bright or clear, but discernable. O-scope shows a lot of noise and dominate freq shift: 1 MHz signal. Reason believed not in foil (much more difficult near edges because foil is thin and shiny. 7/· side make it confusing) Tried all tricks moving up and down on foil, tape unnecessary beams, etc.						

Date 20 Feb Test No. 69

Angle of Attack -4.0 Side convex

Water Temp ____ Room Temp ____ Manometer Tubes ____

Station LE [illegible]

Lens distance from Window on foil

Initial Pointer Reading 30.00

Pointer	Distance from Wall	~~Manometer~~ RPM	Freestream Velocity ft/sec	Laser Volts	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
40.00	13.349	158.6		771.2		1.0336	
38.93	11.921	158.6		765.7		1.0254	
38.02	10.706	158.6		759.3		1.0162	
37.10	9.478	158.7		752.0		1.0064	
35.98	7.983	158.9		740.3		.9895	
35.01	6.638	158.5		724.1		.9703	
34.08	5.446	158.6		704.5		.9434	
33.11	4.152	158.9		678.8		.9077	
32.00	2.670	158.7		629.5		.8425	
31.04	1.388	158.8		554.2		.7414	
30.89	1.188	158.8		536.1		.7170	
30.72	.961	[illegible]		514.0		.6875	
30.58	.774	[illegible]		[illegible]		.6493	
30.41	.547	158.4		450.7		.6043	
30.25	.334	158.4		405.9		.5443	
30.10	.133	158.5		350.1		.4691	
30.00	.000	[illegible]		343.6		.4604	
[illegible]	-.160	[illegible]		[illegible]		.6391	
29.79	-.280	158.7		[illegible]		.771[illegible]	

Date ~~31 Jan~~ Test No. A1

Angle of Attack 0.0 flat side to laser

Water Temp 23 Room Temp 75 Manometer Tubes 7/4

Station Velocity constant

Lens distance from Window —

Initial Pointer Reading —

~~Pointer~~	Distance from Wall	Manometer	Freestream ~~Velocity~~ ft/sec	Laser	Velocity at Point ft/sec	Non-dimensional Velocity at Point	
MANO	Velocity ft/sec	10 sec Avg RPM's		Vel/RPM			
618.9	10.216	161.5		.06336			
616.6	10.197	161.4		.06318			
617.2	10.200	161.4		.06320			
618.2	10.210	161.4		.06326			
617.4	10.203	161.3		.06325			
617.0	10.200	161.4		.06320			
618.4	10.212	161.5		.06323			
617.8	10.207	161.4		.06324			
618.1	10.209	161.5		.06321			
617.6	10.205	161.5		.06319			
613.2	10.215	161.5		[illegible]			
620.0	10.225	161.5		.06331			
618.1	10.209	161.5		.06321			
619.0	10.217	161.5		.06326			
617.4	[illegible]	161.6		[illegible]			

Avg = 10.209 Avg = 161.46 Avg = .06323

.06323

Date 2 Feb Test No. A2

Angle of Attack -4.0 flat to laser

Water Temp 82 Room Temp 75 Manometer Tubes 7/4

Station Velocity Constant

Lens distance from Window __________

Initial Pointer Reading __________

~~Pointer~~	~~Distance~~ from wall	~~Manometer~~	~~Freestream Velocity ft/sec~~	~~Laser~~	~~Velocity~~ at Point ~~ft/sec~~	~~Non-~~ dimensional Velocity at Point	
Mano	Velocity ft/sec	10 Sec Avg RPM		Vel/RPM			
593.0		158.4		.0631333			
592.2		158.4					
591.8		158.4					
593.0		157.6					
592.3		158.4					
592.1		158.4					
592.3		158.3					
591.9		158.4					
592.8		158.3					
591.9		158.3					
592.2		158.4					
592.1		158.3					
591.6		158.4					
593.1		158.4					
592.2		[illegible]					

Avg = 592.36 Avg = 158.3[illegible]

Vel = 9.99[illegible]71

Date 6 Feb Test No. 3A

Angle of Attack +4.0 Side flat

Water Temp 77 Room Temp 75 Manometer Tubes 7/4

Station Velocity

Lens distance from Window ______

Initial Pointer Reading ______

~~Pointer~~	~~Distance from Wall~~	~~Manometer~~ RPM	~~Freestream Velocity ft/sec~~	~~Laser~~ ~~Volts~~	~~Velocity at Point ft/sec~~	~~Non-dimensional Velocity at Point~~	
Mano				Avg Mano	→ 600.75		
				Avg. RPM	→ 159.69333		
598.5		159.4		Avg Vel	→ 10.0637		
600.3		159.5		Vel/RPM →		.0630188	
599.4		159.6					
599.2		159.6					
600.2		159.6					
598.7		159.6					
599.3		159.6					
600.4		159.7					
600.9		159.8					
601.8		159.9					
601.2		159.8					
601.9		159.7					
601.5		159.8					
604.8		159.9					
603.0		160.1					

Thesis 186348
T347 Tettelbach
c.1

Investigation of velocity field about a two dimensional plexiglass ogival foil using the laser dopler anemometer.